Connected Consumption: The hidden networks of consumption

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Connected Consumption: The Hidden Networks of Consumption

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***Abstract*—**

In this paper, we present the Connected Consumption Network (CCN) that allows a community of consumers to collaboratively sense the market from a mobile device, enabling more informed financial decisions in geo-local context. The mobile application allows one to log one's wish list and itemized list of transactions to form a social network around the list of interests. Individuals can share this data to inform and guide others in a timely, personal and contextual manner when they are shopping for a product or seeking a service. It can also help people connect opportunistically in a local area to make group purchases, to pick up an item for a friend, and to perform reverse auctions. We present the design, architecture and concept prototype. We simulate a social network with three months of existing credit/debit card transaction data in various geographical areas to analyze the mutual information and recommendations that can be shared among networked consumers.

***Index Terms*—Social networking, mobile, shopping, collaborative, location based recommendation, interest driven network**

I. Introduction

Ubiquitous availability of mobile devices that sense the user's context and interest will network consumers in real time to help each other fulfill their short term and long term goals. We present the Connected Consumption Network (CCN), an on going research platform that we are building to bring together communities of consumers with complementary interests. CCN is designed to help consumers guide their financial behavior with the help of feedback from friends and experts in the social network. Our goal is to investigate how individuals may benefit by being aware of the consumption behavior and the transactions of their social network.

Everybody carrying a mobile device and the device being able to detect what we purchase and consume, allows us to understand our time variant interests. These interests can be mapped across the social network in order to allow users to utilize the collective knowledge of people with complementary interests. By mapping the interest network, identifying the influencers and the influenced and tracking the actual financial transactions occurring through the recommendations allow us to quantify the economic activity surrounding a social network. For our initial research, we are trying to understand the structural dynamics of such network. This will allow us to find the experts, identify the influencers and the influenced.

We approach this by creating the CCN environment that connects consumers with other consumers of similar interests. Statistical and machine learning approaches have been used to infer user's friendship network and physical context in the Reality Mining project[1]. Similary, wish lists and purchase logs are used to establish interest networks through CCN as they are shared (opt-in) with their friends and public through the mobile device. Combined with the financial information and the social network, it forms a natural idea market for making informed financial decisions.

The system is designed to capture itemized level transaction details from participants through manual input and capturing relevant pictures with the camera. Currently, there is no way to obtain the itemized level transactions of individuals across their spending categories at point-of-sale (POS). Merchants have POS transaction databases of customer's itemized purchases, but they are closed to those merchants. We overcome this limitation by making a user contributory CCN.

By utilizing geographical context from the mobile device at the time of logging and receiving recommendations, we make CCN relevant to the physical context. The information that is pulled and pushed is guided by the wish list, purchase logs and previous financial transaction behavior. By logging itemized transactions, viewing and sharing of these transactions, the system allows us to microscopically track the "word of mouth" marketing and the network externalities that arise in the market[2].

A. Motivation

Current informed consumers are very frequent shoppers or use the web heavily (i.e. Angie's List, Consumer Report or CNET Reviews) to inform them about the price, features and reviews of products. Very often they expand this knowledge by asking their friends for references and experiences[3]. The time consuming process produces tacit knowlege on the product choice and related items that can be used for recommendations.

By tying this information with the social connections, we build an information network around the selection, purchase and the post sale experience. The system allows identification of experts with a balanced point of view by tracking their utilization of different merchants and the accounting of actual

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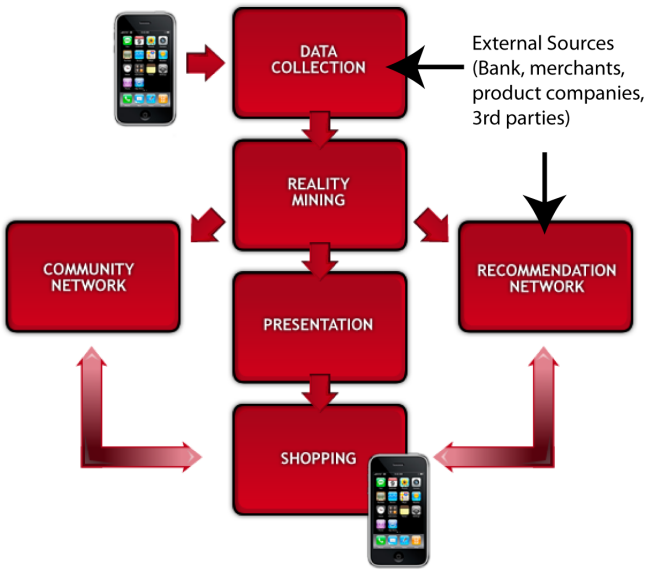

Fig. 1. System Architecture

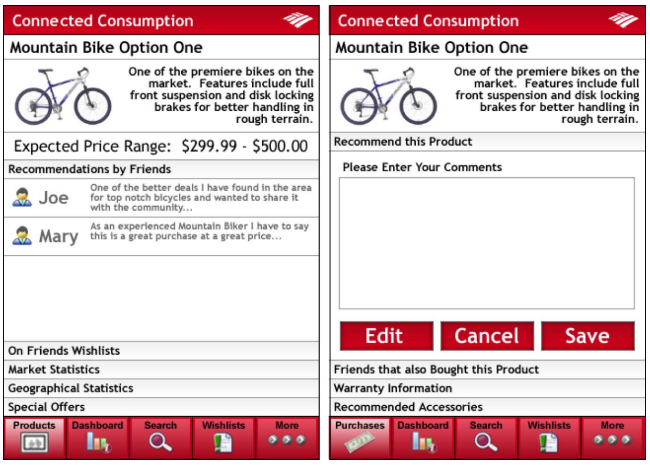

Fig. 2. Concept: Left) Product with recommendations by friends. Right) At point of sale, one can recommend to friends for discount or rewards.

purchase activity (which informs others of the true experience with the product and service). Automatically linking to a post sale community for addressing problems and enabling reverse auctions by pushing items based on wish list are some of the possible benefits.

II. System Design

The system is designed as a user contributory system for purchases so that people can collectively collaborate to understand the market and form a community around purchases. The system architecture is composed of the mobile frontend, backend web services, reality mining[1] module to understand the users, data repository for storing trasactions, social network management and plugins to external services and data sources (Fig. 1).

A. Limitations in Current State of Transactions

Currently, itemized list of purchases from customer's POS data are privately owned by merchants. Merchants are protective of this data and cross referencing requires close business partnerships. More importantly, customers do not have access to this data to evaluate their purchases or monitor their financial behavior without manually tracking them. Beyond protecting privacy, the information gives the merchants a competitive advantage, so there is no willingness to share this information. Banks are able to capture all types of transactions except cash transactions. However, the details of the transactions only capture merchant level information and the itemized list of products and services is not available.

B. Mobile Application

The current system is designed to log transactions manually. Ideally, we believe that NFC (Near Field Communication) and digital receipt[4] can enable an automated and certified log of purchases to avoid forged data. However, these systems are not availabile in production environment, so we designed the system to rely on users' manual contributions for research purposes.

When a user logs a transaction, the item name, categories, price, and merchant name need to be input manually. Additional annotation is optional. User can also attach a picture by using the camera. The geographical coordinates and time are logged automatically.

When a user is interested in an item, one can add it to the wish list. This triggers a search among the social network to find people who have made similar purchases and present them to the user (Fig. 2). Individuals who have experience purchasing a specific product have performed background research to inform others about the product. Users can message them or directly call them. The prior experience of friends and the social network can be utilized to make more informed purchase decisions. It also opens opportunities for friends and public to reverse auction on the wish list item by bidding offers to them.

C. Web Service

The web service provides capabilities for data collection, social networking and reality mining. Mobile phone uses REST API's to store wish lists and purchase lists. The reality mining engine[1] utilizes the collected information over time to infer user's interests.

The user objects contain wish lists and items purchased with most recent items having higher weight to better model user's transient interests. People are connected with others through a friendship network. Items can be shared among friends or the public. For future work, we would like to utilize common sense database[5] to map out user's interests beyond what they specify through their items so that those public information can be intelligently matched. Each interest would be mapped with a weight to be prioritized for constructing social network and filtering recommendations.

D. Recommendation System

Traditional recommendations are personalized to the level of individual's interests that are specified through surveys and subscriptions during purchase of products or services. However, normally individual's interest evolves through time, location and context. When a person has bought an LCD TV, one will not probably make another big investment in electronics, but focus more on the content. However, useless catalogs are sent by the merchants with a wide variety of offerings that are irrelevant to the user. They have no situational awareness of the customer to provide the user with what might be useful. They have no information about their financial goals, desires for purchases, or timing of their purchases to help people's future spending.

In our system, we utilize their purchase behaviors and financial information to filter appropriate recommendations versus potential spam. Our system tunes the recommendations one gets based on the frequency of purchase, average size of purchase, average spending in a month and the usual categories of spending. If one purchases childcare product only once a month, recommendations will be tuned to once a month. If one has a average balance of $1000 a month, any purchase recommendations beyond this budget would be considered spam.

E. Applications

We envision various services can be implemented on top of CCN that can be beneficial for the community of consumers. The consumers can get different level of aggregate data on how different products are consumed in different geographical areas and demographics, generating real time consumer reports and consumption index.

From the business side, CCN can be utilized for merchants and product companies to tap in to fulfill wish lists of people and provide contextual marketing channel. This opens up opportunities for reverse auction so that consumers may save time in their product search.

Financial services have incentives to participate in this system to handle the transactions and provide contextual financial offers in a timely manner. When the person is interested in purchasing an item, when the person is at the point of sale, or when the person needs to handle financial transactions with other users, the bank can be an authority for their legitimacy. Value added service to merchants can be provided for premium fees or through separate payment network.

Many times people purchase products and services without much awareness of their spending habits or consideration of the future impacts. Rarely are they well aware of their budget. Current budgeting tools are limited in giving real time feedback when one is considering making a purchase. Research in retail stores indicate that 20% to 60% of purchases occur due to impulsive purchase[6]. CCN allows spending to be tracked on the mobile and allow it to be categorized and sorted so that people can view their consumption summary in real time. With the help of the social network, it also allows one to be informed of how one compares in different spending categories (i.e. my coffee spending, travel spending) with others in similar financial contexts.

III. Concept Validation

The assumption of CCN is that participants contribute and share purchasing records at an itemized level. At this early stage of building the prototype and user testing, we have not been able to collect sufficient data to perform a meaningful analysis. Therefore, we utilize anonymized data of three months of credit card and debit card transactions from the bank's data warehouse. Though detailed information about purchased products or services is not available, we are able to utilize the merchant level information in the bank's data to draw insightful observations and explore the network value of each individual's transaction history.

A. Methodology

We randomly selected 200 card users between ages 20 and 50 from specific metropolitan statistical area (MSA). We were given their credit/debit card transaction records happening in the first three months of 2008. Though item level information cannot be obtained, we have merchant names and shopping categories available for each transaction. While there are more than 35 categories of credit/debit card transactions, we are only interested in studying 20 of them which include 'Food Stores', 'Restaurants/Bars', 'Clothing Stores', 'Electronic Appliances', etc. These 20 categories represent the most common shopping behaviors we experience in our lives. Online transactions were filtered out, so that only the physical store transactions were taken into account. Categories like 'Cash advance', 'Payment', 'Refund' are discarded in our analysis.

Each individual's purchasing behavior or 'consumption pattern' can be determined and mined from the merchants s/he visited in the past. As a simpler model, each customer's consumption pattern can be approximated by a length-20 vector where each element represents the amount of money he spends in that category. The relative distribution and absolute amount of spending in different categories can well reveal a consumer's interests, habits, and living styles. We are mainly interested in demonstrating: 1) the consumption report obtainable from the aggregated information in the large scale network s/he is connected to 2) the amount of recommendation and similar purchase inforamtion consumers can receive from their friends network.

B. Results and Analysis

We first generate a friendship network by randomly clustering the 200 customers into different groups. Each group consists of 2 to 12 members. Every pair of members within the same group are connected as friends. Then, we draw weak links between two customers in different groups. The number of weak links is uniformly distributed between 0 and 100. We define the 'Mutual Information' as the number of common merchants that a customer and his/her friends have visited, implying that they have common interests and knowledge on these merchants; and 'Recommendations' as the number of

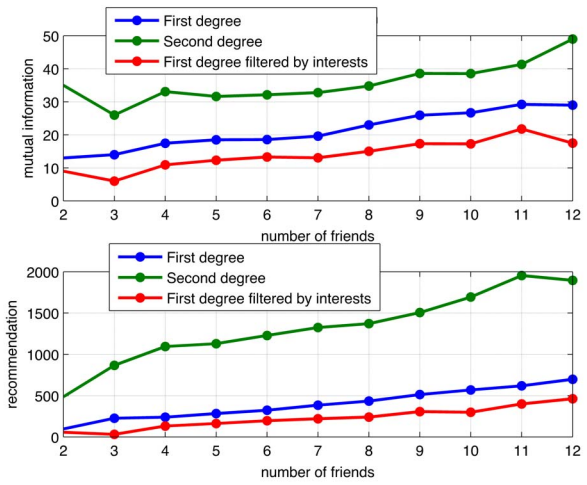

Fig. 3. Mutual information (MI) and recommendation (RC) customers receive from their social networks. Top: MI, Bottom: RC.

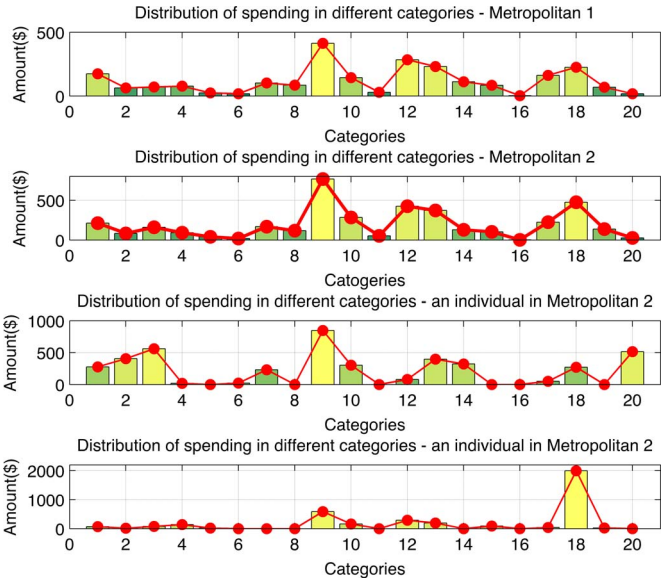

Fig. 4. Customers compare their own spending in each category with other users in the same geographical location and age group

merchants that at least one of the friends has visited, but he/she has not. As we see, there is a large potential to explore the information hidden inside the social network. The amount of mutual information and recommendation grows linearly with the number of friends each individual has. Approximately, each customer can potentially receive around 45 recommendations from each friend he/she has for three months.

If we further consider the second degree social network (i.e. friend's friends) opinions, the amount of information gets significantly amplified, as well as the privacy and spam concerns. It can potentially annoy individuals when hundreds of recommendations are received each month. A user can therefore filter out information according to his own interests and preferences. In Fig. 3, the MI and RC are filtered by the top 5 spending categories, as shown by the curves at the bottom. The filtering effectively reduces the amount of information received, while potentially increases the quality or value of the information.

Fig. 4 displays a potential user interface a customer can utilize to compare his own spending in each category and the average amount other consumers spend in the same geographical location and age group. The two subgraphs at the top represent the shopping patterns for two major metropolitan areas in the US. The two subgraphs at the bottom represent two customers living in the second metropolitan area. Such an interface allows a customer to utilize it to get feedback on his/her consumption level and reflect on their budgeting and financial planning.

Fig. 5 shows a user scenario when a customer receives multiple recommendations on restaurants from his/her friends. In this case it was generated from MSA-2 with over 500 transactions per restaurant. Depending on the occasion, s/he can make a choice among these options based on the expected spending. Similarly in CCN, customers can share their restaurant experiences and allow users to make a choice based on

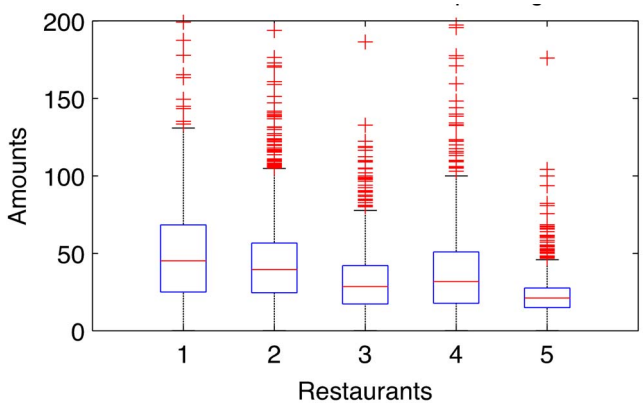

Fig. 5. The distribution of individual transactions in five different restaurants

his/her own preferences and financial situation.

IV. Discussion

A. Mobile Commerce

Mobile shopping services in Japan generated $1.84 billion in 2004, which represented about 8% of all on-line sales of physical products in Japan that year. 15% of them were in fashion-related products[7]. Push mail and discount coupons integrated with merchants and other broadcast media (radio, TV) were the driving business models. Expanding on such potential, our research focus is on building a context aware, socially aware, finance aware mobile shopping experience.

With mobile communication becoming pervasive, [4] and [8] presents different types of digital payment and digital receipt systems in mobile and ubiquitous computing environments. Although they present possible business models around these technologies and mention the social adoption and usability as challeging issues, their main focus is on

making current payment system more efficient by utilizing digital receipts and mobile devices.

We present a more holistic framework where mobile transactions can become more relational experience by embedding social network and personalization around the mobile shopping experience. [9] show that when friends are involved in transactions, the transaction becomes relational where future consequences are taken into account during transactions. CCN presents opportunities for making shopping experience more relational.

B. Long Lived and Transient Interests

The mobile phones that detect user's financial transactions will be able to detect the user's long lived and transient interests[10]. This is very important in making recommendations more relevant to the context. The long term interests can be aggregated instead of alerting the user all the time. The transient interests can be used opportunistically when users are geographically in closer proximity to a store and in a timely manner when they have higher probability of purchase during weekend or evening hours. We do not want to alert the user with furniture store sales when the user is commuting to their work.

C. Privacy and Security Issues

Sharing financial transactions may be a very sensitive issue where cases like Amazon transactions automatically being published on Facebook caused flares[11] to quickly withdraw the application. We ensure that our design does not prevent any unwanted spread of financial information by giving users the control of which items to share (opt-in). Those that are closed are only used for generating aggregate information. We consider issues addressed by [12] in the analysis of social networks from aggregate data to prevent possible attacks that may reveal private information.

There is uncertainty about whether the consumers are willing to accept mobile advertisements[13] on their phones due to spam and unsolicited communications on a device that they always carry around. The small screens also limit the effectiveness of the advertisment. However, market research shows that consumers are willing to accept advertising if it brings direct benefits to them through coupons that can be used in brick and mortar stores[14]. Research of SMS campaigns[13] in Europe have shown that people like the advertisements they receive from trusted sources. Studies also show that 23% of people are willing to forward the advertisements to their friends. In other research surveys, 65% wanted personalized advertisements and 45% wanted location specific advertisements indicating that our design around social and physical context is critical for the adoption of recommendations through CCN.

V. Conclusions and Future Work

Our simulations show how much more "information aware" consumers can be as they are socially networked through a CCN like system. Current information retrieval systems usually inundate people with information. However, by building a system of actual transactions and establishing connection to share these purchasing experiences among friends and social network, we can increase the quality of information and recommendations. We will be able to know who are the true experts or experienced from the purchases they have made and waste less time on random reviews. CCN is an attempt to bring such enhanced social shopping experience to the mobile context while helping consumers to help each other for smarter spending. We will be refining the system to scale to 100's of users for live itemized data collection and evaluating recommendation algorithms among volunteers in a campus environment.

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