BUSINESS INTELLIGENCE AND PREDICTIVE ANALYTICS FOR MOBILE COMMERCE

Siva Viswanathan[+]

INTRODUCTION

Traditional marketing strategies and market research analytics have largely been constrained by the lack of availability of granular data about customers as well as by the limitations in collecting and processing such data. Market segmentation strategies for instance, have been typically based on *geography* (location, address, etc.), *demographics* (gender, race, age, religion, nationality, occupation, income, disabilities, mobility, education, employment status, family size, etc.), *psychographics* (personality, opinions, values, attitudes, interests, or lifestyles), and *product usage* at an aggregate level (usage rate, brand loyalty, usage occasion, user-status, etc.). The purpose of these segmentation strategies have been to improve product differentiation, provide customized offerings, design price discrimination strategies, promotions, etc. While data about consumer demographics, psychographics, etc. have provided useful insights to firms, the dramatic developments in ICT have freed us from these traditional constraints. Firms no longer have to rely on coarse strategies based on aggregate data, on unreliable self-reported survey-based data, or on abstract and amorphous user-segments.

With the dramatic improvements in the ability to capture and store vast amounts of granular data about consumers, as well as the availability of tools and techniques to analyze massive data sets, businesses are increasingly becoming aware of the possibilities for leveraging this information to design and implement optimal strategies. In particular, the ability to make sense of granular data about consumer behavior has triggered a paradigm shift, with the move away from mass-market strategies to individual customer-focused pricing, promotional, product-positioning, and marketing strategies. A well known example is the use of recommendation systems by Amazon.com, which leverages the deep knowledge of each individual customer's buying patterns and browsing behaviors to deliver targeted personalized recommendations. More recently, with the growth of Web 2.0 and the "networked economy", the role of social networks and linkages between consumers has moved to the forefront. Firms are increasingly recognizing the importance of understanding the role of an individual's social network in influencing critical adoption decisions and usage behaviors. Social network analysis and graph mining techniques are increasing our understanding of such social influences, helping generate valuable business insights.

SOCIAL NETWORK ANALYTICS

Understanding the structure and dynamics of social groups is the primary objective of social network analysis. With its roots in graph-theory, and starting with the work of Solomonoff and Rapoport (1951) and Erdos and Renyi (1961), the focus of network analyses has been on the study of entities and the links between the entities. Prior

---

[+] Siva Viswanathan is an Associate Professor at the Robert H Smith School of Business, University of Maryland, College Park, and a Co-Director at the Center for Digital Innovation, Technology, and Strategy. He can be reached at sviswana@rshmith.umd.edu. Additional research studies can be found here.

research studies have highlighted the role of social networks within firms and organizations and examined how social networks can influence economic outcomes in markets. More recently, the focus has shifted to understanding how individual behavior is influenced by their social networks, using data on large-scale networks. For instance, research studies by Christakis and Fowler (2007, 2008) highlight how influences from the social network of an individual (up to three degrees of separation) influenced obesity and smoking patterns. Other studies have improved our understanding of how online networks structures affect real life interactions. With the developments in tools and techniques that enable us to analyze large-scale networks, social network analytics provides an unprecedented opportunity to analyze and understand interactions in social networks and derive actionable insights for firms and businesses.

SOCIAL NETWORK ANALYTICS (SNA) FOR MOBILE NETWORK OPERATORS

In 2002, the number of mobile subscribers world-wide overtook the number of land-line subscribers giving rise to the world's largest "network". The calling and messaging patterns amongst the users of the mobile phone network can be used to construct the underlying social network. Based on a combination of exploratory and systematic analysis of the underlying social network, Social Network Analytics can be used to derive a number of metrics to guide strategic decision making for marketers. SNA can be used effectively to gain a better understanding of the dynamics of user behavior – insights that can be employed effectively to design targeted promotions and ad-placements, optimize marketing expenditures, optimize resource allocation, increase loyalty, reduce churn, offer targeted price-promotions and discounts, and to design effective cross-selling/up-selling strategies. It can also be used to analyze social networks of users to tease out the hidden network structures, and identify the most influential members in a given domain.

> **OBJECTIVES OF SNA:** Design targeted **pricing**, **promotional**, and **advertising** strategies, optimal **incentives** for customers, strategies for **customer acquisition** and **retention** (increase loyalty, and decrease churn), **customer segmentation** strategies, and **fraud detection**, based on *a systematic understanding of a broad range of structural properties of the network, the resource flows, evolutionary patterns and influences, and analysis of group dynamics in the network over time.*

- **Resource Flows:** Understand how information and Influence flow within the network and discover the latent structures inherent in the network.

- **Locational and Temporal Patterns:** Understand how behavior in the directed and weighted network is influenced by (or changes with) location and time.

- **Influencers and Early Adopters:** Identify "influencers" and "early adopters" and how network structure correlates with adoption patterns.

- **Diffusion:** Understand how information, products, and service offerings, diffuse within the network.

- **Clusters and Patterns:** Understand similarity and differences between individuals (or groups of individuals) based on network-based distance metrics, and uncover community structures in the mobile calling network.

- **Network Evolution:** Understand how the network topology and network structures evolve over time and the exogenous factors that drive network evolution. Understand the correlation between network evolution and behavioral outcomes.

- **Visualization:** Develop customized techniques and tools for the analysis and visualization of the mobile calling network.

- **Impact of Exogenous Factors:** Understand how exogenous interventions (including pricing, promotions, discounts, offers, etc.) change the dynamics of the calling/messaging patterns in the network. Understanding these changes and the dynamics of user behavior in the network during such events is essential to designing optimal targeting strategies.

USING SNA TO DRIVE BUSINESS INSIGHTS

CUSTOMER ACQUISITION STRATEGIES

Customers buying new services, handsets, or calling/messaging plans are typically influenced by their friends and members in their social circle. SNA can help mobile operators exploit this trend.

Influencing the Influencers: SNA can help identify the best propositions or campaigns for viral marketing and help optimise the campaign for maximum viral transmission. SNA can be used to identify a target group for the campaign. By analyzing a selection of a mobile operator's call records, SNA algorithms can help construct a social network model' of the operator's customer base. This would help identify the communities within and, equally important, the levels of influence that each individual has within their community and across the wider network.

Research shows that when mobile customers change operator, they are heavily influenced by their friends in their decision. SNA for instance, can be used to design effective "member-get-member" marketing techniques. Social Network Analytics can also be used to improve the effectiveness of direct acquisition campaigns.

- Build a network model of the operator's customer base
- Identify "influencers"
- Design "network seeding" strategies

CUSTOMER RETENTION STRATEGIES

Although customer acquisition is usually a key objective for mobile operators, most mobile markets in the developed world are now saturated or approaching saturation. As a result, new mobile customer acquisition has become increasingly difficult. Consequently, it is imperative for firms to design and implement effective customer retention strategies.

Churn rates among mobile service providers are typically very high requiring firms to offer the right mix of incentives, promotions, and resource allocation to retain their valuable customers. While traditional models of churn rely on information about an individual's attributes including usage, historical calling patterns, billing, payment, credit card data, and demographics, among others, it is increasingly becoming evident that an individual's adoption, purchase, and switching behaviors are significantly influenced by their network of friends and acquaintances. In the same way that people share any personal information with their friends, they tell others if they are unhappy with their mobile phone company or if they have changed network. Understanding the structure and attributes of an individual's social network, and identifying the contagion effects then, becomes essential in predicting individual outcomes that have a direct impact on the provider's bottom line.

Contagion in Social Networks: A recent study found that a subscriber with a churner in their social group was twice as likely to churn as someone who did not have a churner in their social group. One question that naturally

arises is whether the number of churners in your social group affects this increased tendency to churn. Is there a threshold cut-off? It also turned out that if there were churner-churner relationships within the subscriber's social group, that subscriber was 7 times as likely as the overall base rate to churn.

Subscribers who are in the environs of recent churners will experience increased pressure from their friends to move networks. The role of the community in churn contagion is crucially important in determining levels of churn contagion, because community members exert a higher influence on each other than can be measured by pure calling circle data.

- **Develop a solution to predict churn based on community behaviour.**
- **Develop a tool to identify "cascades" and "contagion effects" within a network.**
- **Develop SNA metrics for Churn Prediction and metrics for customer retention.**

A recent study by Aral, Muchnik, and Sundararajan (2009), examined instant messaging data for 27.4 million users, the day-by-day adoption of the Yahoo! Go product for over 5 months, and the precise attribute and dynamic behavioural data on the users' demographics.   They find that "adopters have a 5-fold higher percentage of adopters in their local networks". Most interestingly, they find that, "both the number and percentage of one's local network who have adopted are highly predictive of one's propensity to adopt, and to adopt earlier".
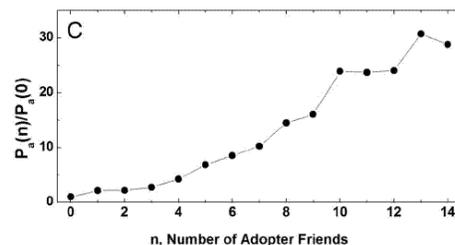
This graph above illustrates how much more likely you are to adopt if you had adopter friends as compared to no adopter friends. If you have only 1 adopter friend in your local community, your chances of adopting doubles. If you have 4 adopter friends, your chances of adopting the product increases by almost 4x, and so on.

Thus, regardless of the reason for the adoption, it's clear that customers whose social community has adopted a product is more likely to adopt the same product. These findings have significant implications for a firm's marketing strategy: a firm can use the activity in the network for improving the predictive accuracy of their models; the firm can make "seed" a few adopters in each community etc. Identifying early adopters, and influencers, in a community (or social network), and designing targeted strategies that build on an in-depth understanding of the user's network promises rich dividends for firms.

Reference: Sinan Aral, Lev Muchnik and Arun Sundararajan. *Distinguishing influence-based contagion from homophily-driven diffusion in dynamic networks*. Proceedings of National Academy of Science, Dec 22, 2009, Vol 106, No 51, pp. 21544-21549.

COLLABORATIVE RECOMMENDATIONS AND CROSS-SELLING

Mobile operators are increasingly turning to new data services and offerings to increase the average revenue per user. The traditional process starts with consumer segmentation based on past experience. Customer segments are typically based on demographics, purchase history, etc. While this has been a promising approach, it does not take into account that people learn about products through their friends. Word of mouth and one's circle of friends influence the purchase decision significantly. SNA can be used to incorporate interpersonal interactions within the user's network to generate more accurate and actionable segmentation strategies. SNA can also provide insights into how a new product or service roll-out is likely to propogate in the network. Understanding these propogation patterns would help mobile operators design the right "network-seeding" strategies.

INFLUENCERS, EARLY ADOPTERS, AND WORD OF MOUTH

Most consumer behavior is influenced by the opinions of people we know – family, friends, and colleagues. Prior research studies have shown that 50-90% of our purchasing decisions are driven by social influence. Yet most marketers, lacking the required tools and techniques to measure such social influence, have ignored these influences.

Influence is a function of a complex set of parameters including communication frequency, intensity, levels of reciprocity and connectedness. An individual's social sphere both influences and is influenced by each customer. When an influencer buys a new product, three to fifteen additional customers may also buy it as a result of her recommendation. And when an influencer leaves, it could very well be that ten or more additional customers will follow her. Knowing which customers carry this kind of influencing power on their friends, family, and associates is critical to the ability of the firm to focus attention and resources where they matter most.

SNA provides the right tools and techniques that enable firms to identify influential customers and target them successfully. SNA can help firms identify influencers, target promotions, campaigns and retention programs, and deliver measurable results for a firm's customer acquisition, customer retention, and cross/up selling efforts.

One way organizations get started with our solution is by using it to identify the influencers for a specific product or service and use them as a primary target for existing promotions. Network Metrics (for example degree centrality, betweeness centrality, closeness centrality, among others) can be used to calculate the importance of each node. Various metrics of the links between the nodes including the directionality of the links, the strength of the links, among others can be derived using multiple measures including call frequency, duration, etc. Time and location of the sender and receiver would be additional dimension of interest. Companies that understand the social nature of every customer and the importance of social influence are moving towards a new metric **Social Customer Lifetime Value**, taking into account the cumulative lifetime value of each customer as well as those influenced by them. Applying these metrics across activities, enables firms to build measurability and accountability into an area of marketing that lacked such discipline until now.

- **Identify the key "influencers" and "early movers".**
- **Analyze uptake for new product/service offerings within communities.**
- **Measure uptake among "influencers" and "early movers".**
- **Design relevant targeting strategies and measure offer uptake among influencers and early movers.**
- **Identify the density and strength of the influencers' networks and ties.**
- **Measure "contagion" effects and "cascades".**

PRICING AND DISCOUNTS: The benefit of marketing to the entire family or household as a unit is well recognised by the mobile operator community. For example, family group tariffs provide increased lock-in, and identifying the household unit is essential for selling fixed network services such home phone lines or fixed broadband. In addition to all this, understanding the family unit adds huge richness to your customer understanding.

LOYALTY AND CUSTOMER EXPERIENCE MANAGEMENT: SNA can be used to enhance the user experience of the consumer website by displaying the recent actions of one's friends.

ADVERTISING AND PROMOTIONS: A good understanding of the network structure (e.g., the number of cliques, and connected components) can help design advertising and promotional strategies. For instance, a network with many disjointed components would lend itself better to a more broad-based advertising as opposed to a more densely connected network which would lend itself better to targeted advertising (targeting the more influential nodes).

Phase I revolves around exploration and understanding. This phase involves exploring the type of network data and using interactive visualization tools that can provide mutiple linked views of detailed call histories and display time series network data. The visualization tool can also help understand the evolution of the network over time. The next step involves generating various network metrics, measures, and patterns in the aggregate data, that help provide a systematic understanding of the overall network and the properties of the nodes and the links. These network metrics and measures are typically used as inputs for the predictive analytics and models.

Phase II focuses on taking the phase one analysis into production. Given the understanding of the network metrics, and segmentation variables, and clusters, the next step involves scaling up this process using enterprise grade network analysis servers. Iterative analyses of quantitative network properties are conducted using the larger data set on calling/messaging patterns in the larger network. The various network scoring algorithms and mining procedures are run in a batch environment.

Phase III involves using the output of the analysis from phase two. Business insights are derived from the network analysis and predictive analytics, and focused strategies are designed and tested. For instance, relevant ads or promotions are targeted on the individuals identified. Outcomes of the designed marketing interventions are measured and refined. The refined predictions from SNA can then be integrated with existing CRM, call centers, or online ad servers.

EXPERTISE @ DIGITS

The role of predictive network analytics is one of the key focus areas for DIGITS. Research studies using social network analytics to understand consumer behaviors in social as well as product networks have provided valuable and unique insights beyond those available through traditional business analytic tools. Researchers in DIGITS are also involved in the study of digital platforms such as Facebook™ and Twitter™ and how firms can leverage these networks to develop and implement strategic objectives.