ABSTRACT

The popularity of smartphones has greatly promoted the development of mobile advertising, especially the development of mobile application (app) advertising. An ad network as a medium between advertisers and app developers can not only provide advertising services for advertisers, but also bring app developers incomes. Existing forms of advertising partnership between advertisers and advertising networks (ad networks) are generally centered on ad networks. However, the advertising-centric cooperation model sometimes cannot meet the specialized advertising needs of advertisers, and the advertisers have to spend more to find the suitable partners. In this paper, the authors consider the advertising problem from the perspective of advertisers. They design an advertiser-centric cooperative mechanism to help an advertiser to attract cooperation from ad networks. They formulate the advertiser-centric cooperative problem into a noncooperative game between an advertiser and a number of ad networks. It is proved that a unique Stackelberg equilibrium exists in the game and the authors have calculated the Nash equilibrium for each ad network. An algorithm that can achieve the unique equilibrium point is proposed. Extensive experiments' results are also conducted to verify the performance of the proposed mechanism in terms of the investment related factors.

Keywords: Ad Network, Advertiser, Mobile Advertising, Smartphone, Stackelberg Game
1. INTRODUCTION

The past few years have witnessed the proliferation of smartphones in people’s daily lives. With the advent of 3G/4G networks and more powerful processors, the need for laptops in particular has begun to fade. According to the International Data Corporation (IDC) Worldwide Quarterly Mobile Phone Tracker, it is estimated that 982 million smartphones will be shipped worldwide in 2015 (IDC, 2012).

With the popularity of smart phones, smartphone advertising is taking the world by storm with the success and productivity it provides to all its users. This form of marketing enables advertisers to send out their promotions to all types of users. It operates on the fact that people have their mobile phones with them all the time and on the fact that 95% of text messages are always read, thereby ensuring maximum interaction with clients in comparison to all the other forms of advertising (Brett Payne, 2014).

There is no doubt that smartphone apps are the future of mobile advertising. The research (Portio, 2013) estimates that 1.2 billion people worldwide were using mobile apps at the end of 2012. This is forecast to grow at a 29.8 percent each year, to reach 4.4 billion users by the end of 2017. Much of this growth will come from Asia, which will account for almost half of app users in 2017. The app download number of 2013 ranging from 56 to 82 billion which beyond many analysts’ estimates (Lim Shiyang, 2014). In 2017, it is predicted that there could be 200 billion downloads.

The excellent prospects of advertising on the mobile applications (apps) have attracted the attention of advertisers. A survey shows that 67% of smartphone owners would rather see ads than pay for premium content (Christopher Heine, 2013) . This means consumers are extremely reluctant to pay up-front for apps, so app publishers/developers have to consider other ways to make money, either via advertising or in-app purchasing. As a result, an online advertising network (or ad network) is needed for both advertisers and app developers. An ad network specializes in an online business matching up advertisers to apps. It works as broker for both suppliers (apps with content that can host ads) and buyers (the advertisers). Each ad network has his own advertising coverage, some may own a large number of apps, while others may not. Different ad networks may have different pricing mode for app developers, such as CPC (cost per click), CPA (cost per action), CPM (cost per thousand impression) and so on. As an advertiser-centric model, CPA may bring more benefits for advertisers compared with other pricing modes. For tractability, we assume that the advertiser only cooperate with those ad networks who pay their app developers by CPA. However, for an advertiser, advertising is usually one of the highest expense or investment. Therefore it is definitely important for advertisers to choose suitable ad networks to lift ROI (return on investment).

Existing forms of advertising partnership between advertisers and ad networks are generally centered on ad networks, as shown in Figure 1. That is, advertisers need to actively compete for advertising space on ad networks. In this paper, instead, we consider from the perspective of advertisers. We focus on an advertiser who select a group of ad networks to participate in advertising. We simplify the cooperative advertising problem between one advertiser and several ad networks. And we find out that the problem can be described as a Stackelberg game. Stackelberg game is usually used to solve the game problem between an individual and group. For example, (Lin Gao & Haobing Wang, 2010) design a Stackelberg game based cooperative spectrum sharing mechanism between primary users and secondary users in cognitive radio networks. (Dejun Yang, G Xue & J Tang, 2012) use Stackelberg game to design an incentive mechanism for mobile phone sensing. Other applications in Stackelberg game can be seen in (B. Li, W. Wang and B. Liang, 2011; HK Garg, X Kang and YC Liang, 2011; M Motani, X Kang and R Zhang, 2012;
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