Activity-Based Advertising:
Auctioning Advertising in Context

Abstract
Internet advertising has seen tremendous revenue growth through its ability to effectively target consumer interest. However, it fails to reach consumers in as wide a range of activities as traditional advertising. This paper describes the opportunity for performing highly targeted activity-based advertising. By better representing human needs and activities, it will become possible to effectively target advertising in everyday situations. Critical to such systems’ success are the extension of advertising auctioning systems beyond keyword advertising. We outline the major challenges to such systems: identifying advertising opportunities and providing advertisers with a way to specify such opportunities, dealing with uncertainty in human behavior, and creating vigorous advertising markets.

Keywords
Advertising, activity inference, ubiquitous computing.

ACM Classification Keywords
Introduction
Advertising is undergoing dramatic change. A recent forecast projected that by 2011, online advertising would grow to $62 billion, overtaking the US newspaper advertising market. Although internet advertising has the ability to better target consumer interest, it only works when people are online. Traditional advertising, by contrast, comes in many more forms than computer screens. For example, signs and radio are encountered throughout our daily routines. These media can reach people when they are more receptive, such as when they are waiting or in transit. However, such media are not personalized. Many consumers find this more traditional form irritating, because the content is typically not of interest.

Activity-based advertising achieves both benefits: reach to everyday situations in which consumers are most receptive, and targeting of advertisements to consumer activities. Specifically, we are proposing a system that determines the current activity of the customer, and when appropriate, delivers advertising that will influence the predicted future activity of the customer. For example, the system might deliver an advertisement for a nearby restaurant to a customer’s cell phone at just the time the customer is deciding where to have dinner. To work well the system must predict future decisions (e.g. that the customer usually visits a restaurant after leaving the train), identify good opportunities to present the advertising (e.g. while the customer is waiting for the train), and above all, present the user with relevant and useful information.

Many consumers have concerns about the application of information technologies to advertising. In the remainder of this paper, we assume a cooperative user who has consented to having advertising personalized to them in exchange for some other benefit. However, it is critical that intelligent advertising systems treat not only the consenting consumers with respect, but also the consumers who have indicated their preference to be exposed to less advertising. Delivering advertisements that are personalized but non-intrusive can be highly effective, as online advertisers have shown.

Architectural Overview
Figure 1 shows a high-level view of the components of an activity-based advertising system. The block on the far left represents the gathering of data on the customer’s activity and the customer’s current context. These data may be collected from a mobile device that the user carries, or infrastructure sensing systems that are able to identify the user. These data are then analyzed to produce descriptions of the customer’s current activity and predictions of the customer’s future activity. For example, the system might identify an activity where a customer is waiting on a platform for a commuter train, and has not yet had dinner.

Figure 1. Block diagram of an activity-based advertising system.
Once good advertising opportunities are identified, the remaining challenge is to find a relevant advertisement to present, or in other words, to connect presentation opportunities with appropriate advertisers. The right hand side of Figure 1 diagrams one approach, where advertisers provide advertisements, bid on how much they are willing to pay for presentations, and specify the kinds of activities that the advertiser would like the customer to be doing when the advertisements are presented. So for example, a restaurant might bid and provide a specification that targets customers commuting home on a nearby train line.

Finally, there is a process by which competing requests for advertisement placement are resolved by a combination of optimization algorithms and economic mechanisms such as auctions. For example, the

Our research differs in that it combines many factors such as location, time and past behavior to automatically detect the activity of a person without requiring the entry of keywords. This creates opportunities for advertising even when the customer is not explicitly searching for information. Our activity-based advertising creates more opportunities for advertising.

Other Research in Physically-Contextual Advertising
Despite the strong commercial interest in mobile and location-based advertising, there has been little work on context-based and activity-based advertising. Context-based advertising generalizes the factors target advertisements from location to other information sources, such as time of day, day of week,

Figure 2. Activity-targeted advertising is more useful and more relevant in consumptive activities. Activity influences both what to put in an advertisement and when to show them.
The importance of when became very clear in an experiment we performed earlier on activity-based advertising [5], the results of which are shown in Figure 2. In this study, participants carried a special phone for a few days that periodically asked them to describe their current activity, and then presented either a random advertisement or an advertisement related to that activity. We found that the activity-targeted advertisements were much more relevant than random advertisements. We also found that advertisements were only useful for activities that were in some way consumptive (eating, watching video, listening to music, shopping, etc.). Additionally, we found that the user’s cognitive and sensory availability affected the receptivity to advertisement. So, for advertisements in to be effective, collecting contextual data is not enough—the data must be synthesized into an activity, and this activity determines both advertising contents (“what”) and user receptivity (“when”).

A more recent project is BluScreen [2, 3]. BluScreen uses Bluetooth device detection to determine user proximity and more effectively target advertisement. BluScreen incorporates an auction mechanism. We are assuming a different model in which an advertising system collects information not only from the advertisement displays, but can also collect information from mobile devices.

Another overview of advertising in a pervasive computing environment, with less emphasis on activity-centered advertising can be found in Ranganathan et al. [10].

Research Challenges for Activity-Based Advertising

Advertising Opportunity Identification and Specification

Figure 3 illustrates a spectrum of activities that might be opportunities for activity-based advertising. Near the top of the diagram, the examples contain higher-level semantic descriptions of customer activity. The identification of these high-level activities will be difficult and extremely uncertain, but they also describe opportunities that will be extremely valuable to advertisers. By contrast, the lower-level items, which are closer to the input data and rely less on inference, will be more certain in their identification of advertising opportunities. We expect that activity described at a variety of levels will be valuable to advertisers, so a goal of our research will be a system that supports variation in the semantic level of the activity identification and specification.

Figure 3. Progressively higher level inference of activity.
Identifying Moments of Potential Influence
A critical goal of an activity-aware system will be to identify the activities that will be valuable to advertisers. Like artificial intelligence in general, activity analysis is challenging—with success more likely when the domain is limited and the quality of input data is high. But by focusing on activity analysis expressly for advertising, it is possible to narrow down the scope of the problem.

In particular, certain activities are more useful than others for advertising placement. The user idly waiting on the train platform is more likely to be receptive to advertising than someone who is reading a book they find very interesting.

In most other applications of activity analysis situations like these represent high uncertainty and poor predictability—situations where it is unlikely that the activity analysis will be accurate or useful. The opposite is true for advertising: in these situations the indeterminacy correlates well with a customer being more open to influence—advertising will be useful and effective.

Defining Competition Structure for Auctioning the Advertisements
A research challenge that is closely coupled with identifying advertising opportunities is specifying these opportunities. The specification should be clear and simple. This is important for two reasons: first, to make it easy for advertisers to use the specification to target their advertising to achieve their objectives, and second, to group advertisers together competing for simple, well-defined opportunities. Competition improves the quality of the targeting and increases the revenue to the advertising provider.

By contrast, existing keyword-based advertising needs very little machinery to identify moments when the customer is open to influence and to specify the kind of advertising that would be relevant. The very fact that a customer is using a search engine correlates well with an “opportunity for influence,” and the keywords themselves specify the kind of search, comparable to the “activity” of the customer. Advertisers simply use keyword combinations to specify targets for their advertising. Identification and specification are easy for keyword-based advertising.

As our earlier study showed [5], however, a keyword-based specification is not necessarily the most appropriate one for everyday environments. Keywords do not identify branching points, and they do not provide a way to specify what and when.

Dealing with Uncertainty
As mentioned in the previous sections, the identification of current activity and the prediction of future activity will have significant amounts of uncertainty. Although uncertainty is a significant problem for many other ubiquitous computing applications, it is not as problematic for advertising. From the advertiser’s perspective, any reduction in uncertainty is welcome.

However, there is still the question of how uncertain situations should be handled. For example, if the advertising provider’s system believes with probability 0.40 that the customer is about to choose a restaurant for dinner, and with probability 0.20 that the customer is about to visit a shopping center, whose
advertisement should be presented? A restaurant 1 block away? Or a clothing store in the shopping center? Simply presenting the advertisement of the highest bidder will compromise the targeting of the advertising. A better approach might be to maximize expected revenue, for example, by multiplying the bids by the probabilities of the activities.

The recent policies of Google and Yahoo! illustrate the importance of mechanism design for choosing advertisements. Both companies sell keyword-based advertising using an auction mechanism. However, there was a subtle difference in way Google determined and ranked placements: they used a ranking based both on what the advertisers bid and on the advertiser’s click through rate, an expected revenue maximization algorithm that that significantly improves Google's revenue. Yahoo! has also adopted a similar approach in their Panama project.

Personalizing Advertising to Groups
Although any advertising system that targets individual users is likely fairly complex, even more complexity arises when groups are targeted. The recent popularity of social networking is likely to lead to many new advertising opportunities as well as challenges.

Evaluating Activity-Based Advertising
Like any complex system, an activity-based advertising system must support mechanisms to evaluate its effectiveness. Different components must be evaluated in different ways.

Activity analysis must be assessed by the performance of algorithms to predict activities that are particularly valuable for advertising. The specification language must be testable on prospective advertisers, allowing them to specify placement characteristics and then observe actual placements in simulated customer activities.

The economic mechanisms (this includes auctions and settlement mechanisms like pay-per-click) must be evaluated using theoretical analysis and simulation studies, to verify that the incentives for all parties are aligned with the successful operation of the system. Here too, it is important to promote ease of understanding and ease of use for prospective advertisers.

Conclusion
We have outlined several issues and opportunities for activity-based advertising. With the recent increased interest in social networks, personalization, and targeted advertising online, there is a clear opportunity for these technologies to make a big difference offline as well.

References


