# SOCIALLY-AWARE SYSTEMS TO PRESENT CONTENT IN PERVASIVE ENVIRONMENTS

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Abstract:     Services relevance is strictly connected to the environment in which they are provided and one service that is highly relevant in a particular environment can be a completely inappropriate service in a different context or in a different environment. To provide relevant and appropriate services, the systems should be aware of their environment, the needs and interests of users and should adapt their behaviour to the specific needs of each particular place and each particular set of users' current interests. The combination of users' personal interactions to build the social context of a public place represents an important support to allow services adaptiveness and thus adjust systems behaviour to best fit users' needs and space characteristics. This paper provides an overview of some aspects that involve the combination of personal interactions to build socially-aware systems. It also describes two experiments, where social context was used to improve services usefulness. Results indicate that this combination can represent an important aspect to be considered in the way to provide users with novel, relevant and suitable services.

## 1    INTRODUCTION

Ubiquitous computing vision foresees a world where computing solutions and communication services are available everywhere and at all time. Achieving this, entails a new generation of computing systems, where the environment is continuously sensed and systems adapt their behaviour to the continuously changing characteristics of the environment. Only then it is possible to provide services that fit the users' needs and that can help them in their day-to-day tasks without being too obstructive. In the broadcasting of content to people in public spaces, e.g. ads, advices or simply some informative content, the selection of suitable ways to deliver the content is central to improve the efficiency of the system. This is why many advertisers and content publishers are constantly struggling to find the best advertising strategies to promote their services. They need to be able to reach the target population that is potentially interested in their products or services and they need to deliver the content properly in order to capture users' attention. On the other hand, the dissemination of large displays and mobile computing devices has created new opportunities for the joined use of these devices, which allows us to

foresee a range of new applications that can go far beyond what is supported today, that is essentially in using these displays for cyclically presenting advertising or broadcasting information of local interest. These devices can enrich public spaces providing users with relevant information and giving advertisers new opportunities to promote their products or services. However, promoting ads in these scenarios requires different strategies from the ones that are used in traditional media like newspapers, radio, TV, e-mail, etc., or even from online ads or traditional notification services where users subscribe some type of services or drive their search for content they want. In public spaces the content is mainly pushed to the users by the promoters, hoping that it will fit the users' interests.

In this paper we provide an overview of some challenges that involve the selection of appropriate ads in public spaces and we describe two experiments where personal interactions are used to support socially-aware content selection and to improve services usefulness. Early results indicate that this can be an interesting approach to the problem of providing users with novel, relevant and suitable services in public spaces.

## 2 CHALLENGES

There are many challenges when developing systems for advertising in ubiquitous computing environments that are not usually found when developing advertising systems for traditional media or online advertising. The particularities of these environments make them very rich in interaction mechanisms and create new opportunities for several innovative applications but, at the same time, many other additional difficulties should be considered. Some of them are pointed out by (Muller et al., 2009); (Partridge and Begole 2009) namely: the way advertisers specify and bid on ads; the extra complexity of processing contextual information and how to use this information in an appropriate way; serendipitous advertisings, privacy and security. Others could be added: the difficulty in obtaining information on the interests of the target audience or how to get user feedback on each presented ad. Globally, these challenges are not related with the lack of content but with two central questions: how to deliver the right content to the right people? and how to deliver the right content in the best context.

### 2.1 Delivering the Right Content to the Right People

How to deliver ads to people who are potentially interested? How to capture users' attention? It is not possible to answer these questions without knowing something about the users' interests or activities. Only being aware of the users' needs the system will be able to respond accurately and according to their expectations. However, interactions in public spaces should be conducted effortless and potentially demand little or no prior training. Additionally, in public spaces, it is important to consider that the content is targeted to a large audience instead of a person and thus rather than having a person profile we need a profile that combines the preferences of the multiple users that may see the content.

### 2.2 The Best Context

It is well known that the relevance of a particular content is strictly connected with the target population and with the context where it will be delivered. An ad can be highly relevant in a business place but it is totally misplaced and without relevance if it is delivered in a school. An ad can be very relevant in a time period before lunch but lost its entire relevance after lunch. However, delivering the content at the right time is not only about hours or minutes. The main question is how to figure the best possible time and the best possible context to deliver the ad. The set of contextual information that can be used to improve content selection accuracy in public spaces is vast. Information concerning the social environment, the physical and social space, available devices to deliver the content, time, and also the views history can play an important role in the selections of the next content to be presented. A better use of contextual information can allow pervasive advertising to be more effective and can also better fit to the interests of the target population but also the interests of the advertisers/publishers.

## 3 RELATED WORK

Several advertisements systems that adopt pervasive computing technologies have been presented and discussed in recent years. A significant part of them are proposed to deliver online ads (Edelman et al., 2007); (Googl inc. 2011) but some of them have been built to deliver context-aware ads in public places. (Partridge and Begole 2009); (Orsi, 2011) use mobile phones as the main device to display ads and other. Other systems explore public devices, like large displays, in public spaces combined with personal mobile device to understand users' interests and activities and thus to deliver ads for groups of people instead of a person. (Partridge and Begole 2009) explore how can histories of contextual data help target advertising more effectively. The BlueScreen (Payne et al., 2006) uses Bluetooth-enable devices for identifying users and it explores history information of past users' exposure to certain sets of adverts. (Holleis et al., 2010) combine public screens and mobile devices and explores personal user profiles and explicit input from users in order to provide appropriate ads. They use the users' mobile phones to store information about their owners, track their activities, and let them interact directly with the display. There are many proposed systems that try to provide personalized ads to individuals or for recommending content to people in public spaces but few of them base their decisions in the social context that represents the place visitors' interests.

## 4 SELECTING ADS

When developing systems to delivering ads in public spaces, there are two viewpoints that should be taken into consideration: the advertiser viewpoint and the

consumer viewpoint. While the viewpoint of the advertiser is easily to include in the system behaviour using relatively simple contextual rules, including the consumer viewpoint could be a complex task.

## 4.1 Social Interests of the Audience

We build a social characterization of the public space using information from personal interactions. Each user is associated to a bag of tags that represent its past interactions. Tags that are used more recently are associated to higher weights. The system also distinguishes between users that are currently in the space on users that already leave the space giving higher weights to present users. All these information is combined into a dynamic social model of the place. The social model is combined with a set of contextual rules that characterize each ad to decide what and when to present a specific ad.

## 4.2 Ads

When create an ad, there are essentially two aspects to be considered. The content and its appearance that should be chosen to attract users' attention and the preferable contextual conditions in which each ad should be selected. The first aspect requires special attention from the design viewpoint and it is not the focus of this work. The second aspect is a central question in the selection process. It represents the advertiser viewpoint of the preferable conditions under which the ad gets more added value. In this case the advertiser may define a set of contextual rules per each which include rules about: time, weather, category, a set of associated keywords, location and the number of times to be presented.

## 5 EXPERIMENTS

Both systems described in next subsections were developed with the main goal of delivering appropriate information for people in public spaces. Both use information acquired from user mobile devices interactions in the form of tags (Bluetooth and NFC) to build socially-aware systems and to support their decisions about what is the best ad to be delivered at each time.

## 5.1 Public Ads with Bluetooth

In this system we explore Bluetooth capabilities as a medium to express users' interests. Users express their interests defining a profile in the system or spontaneously interacting with the system using keywords in their Bluetooth device name to specify their interests. Using Bluetooth scanners with different ranges, the system differentiates two types of interaction zones: a mobile zone and a display zone. This is used to identify the user location and thus to select the most appropriate device to deliver the information. When he is detected within the display zone his profile and his interactions are processed conjunctly with profiles and interactions of other users in the space and they are processed to support decisions on the next content to be presented in the public display.

### 5.1.1 Selecting Content

The first task is to decide if every ad can be presented in the public display or if the ad is not classified as public and thus it should be delivered only to the users' personal mobile device. In the mobile zone the system delivers new pending ads for registered users according to their profiles. In the display zone, if there are no Bluetooth devices the display presents cyclically available public ads according to the social context. If there are registered devices the display presents ads related to the profiles and general content. If there are explicit interactions (using keywords in the Bluetooth device name) the system searches for related ads (related to the topic of the keyword).

### 5.1.2 Evaluation and Results

After 3-weeks of experiment, the system detected 103 distinct mobile devices and 23 of them are registered in the system. The ratio of detected devices that received messages was 22.3%. During this period the system delivered 62 personal messages, corresponding to 14 distinct messages, to 23 distinct students. After the experimental period, we've asked the users to fill a questionnaire where they were able to express their opinion. More than 73% of them refer that the system presents some benefits over common online software to support students/teachers interaction.

## 5.2 Public Ads with NFC

Using NFC as interaction mechanism, users are able to explicitly express their interests in a particular moment. This allows the user to directly access to the desired information using his mobile device but, at the same time, the combination of the multiple interactions of the users allow characterizing the

space interests, in the form of a social profile, and thus presenting in a public display ads in which other people might be interested in. This allows delivering to people in the place the ads that are representative of the interests of people who attend the same space and thus possibly with similar interests.
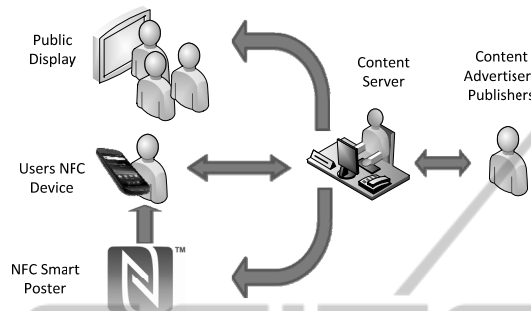


Figure 1: Public Ads with NFC.

### 5.2.1 Selecting Ads

The system architecture can be seen in Figure 1. Each NFC tag is associated to a category of ads (food, clothes, shoes, etc.). By reading the NFC tag the user could access to a web page with a list of ads with a short summary (the user may select each specific ad and read more information) that are related to the category in the NFC tag. To select the next ad to be presented in the public display we realize a matching between the ad, contextual rules and the real context (social context), and we use the presentation history to avoid the presentation of the same ad too often.

### 5.2.2 Evaluation and Results

We have run a preliminary evaluation with four users to provide a better insight into the system, which may identify new issues/problems to consider, and to obtain initial feedback on users' acceptance and perception of the system main features. The prototype includes a smart poster with three distinct NFC tags and a display that presents content related to the place interests. The system includes 5 ads within each category (NFC tag) which totals 15 ads.

All users referred that the usability of the system as a strength. However, three of them referred that they did not have associated the behaviour of the display to their interactions. This may be related to the time period in which the users stay in front of the display (because the display does not respond immediately to the users' interactions in order not to denounce their actions and preserve their privacy)

but can also mean that some adjustments may be needed in the behaviour of the display.

## 6 CONCLUSIONS

We propose an approach that combines public displays and personal mobile devices for delivering relevant content in public spaces. It combines tags from personal interactions to build a social context of the public space and uses this information to deliver appropriate content to people in public spaces. We run two experiments based on those principles. Initial evaluation results suggest that the combination of public displays and tag-based interactions from personal mobile devices represent an interesting combination to provide relevant and personalized information for users in public spaces.

Currently we are working in different algorithms for representing the social context and for improving the content selection in the public display. We are analysing: include more information on the algorithm; contextualize users' interactions (location, organizational context) giving a contextualized sense to the users interactions and defining an economic model that appropriately represents the added value of intentional interactions and social context.

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