Competing for your Attention: Negative Externalities in Digital Signage Advertising

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ABSTRACT
In this paper, we propose to model attention consumption of advertisements as a negative externality. We examine the methods of maximum permissible values, fees, and tradable certificates to cope with the negative effects. We propose to integrate auctions for tradable attention certificates with auctions for advertising slots on digital signage. This method allows us to implement tradable certificates with relatively low transaction costs. It enables us to define a maximum amount of attention that is consumed at a certain location at a certain time. It is guaranteed to stay within these limits while causing only minimum costs for advertisers.

Keywords
Advertising, attention, digital signage, negative externality, auctions

INTRODUCTION
If you watch a science fiction movie today, like Blade Runner or Minority Report, a recurring theme is that public space is full of advertisements, all crying for your attention. This property alone does often let the future look bad and uncomfortable. Even today, if you enter places like Shibuya Crossing (Fig. 1) or Times Square (Fig. 2), you face an overkill of advertisements, letting the vision presented in the movies seem ever more realistic. But is this development of ever more advertisement a fate we cannot escape? Certainly, this question is not only a technical but also an economical one. If we look at internet advertising, recent developments can give us more hope. At first, advertisements in the Internet were relatively static images, presented throughout the text, that could easily be ignored. New technological developments, like animated gifs and Flash, led to the spreading of animated advertisements. These used the fact that the property of animations to draw attention is hard-wired in the human brain. Thus, animated advertisements can hardly be ignored. This development culminated in spam mails, aggressive pop-up windows and screen filling animations, which attracted the dislike and even hate by many users. As countermeasures, spam filters, pop-up blockers and ad blockers were developed, so that the situation merely looks like a war between advertisers trying to sell their products and users trying to protect their attention.

LEAVE BLANK THE LAST 2.5 cm (1") OF THE LEFT COLUMN ON THE FIRST PAGE FOR THE COPYRIGHT NOTICE.

But unknown to many users, most money is today made with a much more decent kind of advertising: Those little, decent "Sponsored Links" shown on the right of a result page when you search for something at Google. Few people are really annoyed by these advertisements, and some even consider them useful when they present them with information they really searched for.

The interesting question now is whether in public space we have to go through the same development as in Internet advertising and live in spaces that distract us and cause bad emotions, of if we can skip this phase and directly go to decent, targeted advertisements. If we manage this, we could live in a world where decent advertisements are embedded into the image of the city, resulting in a place we really love to live in (Fig. 3).

Figure 1: Shibuya crossing in Tokyo.

RELATED WORK
In [6], the concept of using auctions to sell advertising space on digital signage has been introduced. In that work, context information is gathered in terms of the Bluetooth IDs found by a Bluetooth sensor. This information is then provided to the different advertisements, which use it to generate their bids for having themselves shown on a

digital display. The advertisement with the highest bid is then shown for one advertising cycle. The auction mechanisms used for Internet advertising, for example by Google, are analyzed in [1]. The problem of negative externalities and its possible solutions are explained in [7]. A general overview of work done on situated public display is provided in [5]. An overview of problems that occur when situated public displays are used as information system is given in [3,4].

Figure 2: Times Square in New York.

NEGATIVE EXTERNALITIES IN ADVERTISING

Obviously, for each individual person, attention is a limited resource. If attention is spent for one task, for example looking at an advertisement, less attention is left for other tasks. Thus, each advertisement you look at causes some 'attention costs' to you. On the other hand, the advertisement may convey some useful information for you and thus cause a certain benefit. If the benefits are higher than the costs, you are happy that you have seen the advertisement. If, however, the benefits are less than the costs, you may become unhappy or even angry about the advertisement. Thus, there would be a certain optimum amount of advertisements such that the average benefit is maximized. Unfortunately, if the market is not regulated, the amount of advertisements is much higher that the optimum amount.

This is simply because advertisers don't pay for the use of your attention. Thus, the costs that occur because your attention is used are external to the advertisers calculations. This is called a negative externality. In this case, the only cost that influences advertisers calculations is advertising space, finally resulting in every public space being covered by moving, colorful electronic advertisements crying for your attention.

In principle, there are three methods to cope with negative externalities: Maximum permissible values, fees and tradable certificates. Each of these methods requires that the amount of attention consumed by an advertisement can be quantified somehow.

PREREQUISITES: A METRIC FOR ATTENTION

Unfortunately, in order to control the consumption of attention in public spaces, we need to measure it. It is obvious that a perfect metric cannot be achieved, and the more exact we measure the consumption of attention, for example using EEG, fMRT, eye trackers etc., the more expensive it is. A relatively simple method to measure the amount of attention that is consumed by different categories of advertisements is measuring dual-task performance [6]. With this technique, test persons would have to do a primary task, for example solving mathematical or geometric problems. At the same time, they would be presented different kinds of advertisements. The degradation in primary task performance would then allow to draw conclusions on the distraction by the advertisement. It is important to note that for our case it is not that important that the metric is exact, as long as we have any metric. Advertisers would over time try to cheat the metric and attract as much attention as possible with a low metric value. Examining the cheating strategies of advertisers would us then allow adapting the metric itself to better cope with reality.

Figure 3: Regulated Advertising at the Prinzipalmarkt in Münster.

MAXIMUM PERMISSIBLE VALUES

The usual method to cope with advertisement today is maximum permissible values. In many cities, the amount and style of advertisements is strongly regulated. To conserve the cityscape, for example, many cities require advertisements to be in certain colors and shapes (Fig. 3). In some countries, advertisements on highways are prohibited. With maximum permissible values, regulators can be certain about the amount and style of advertisements, but they cannot be certain about the costs caused to advertisers by the regulations. To some advertisers an attention-attracting advertisement might be

worth much more than to others. By requiring each advertiser to attract the same maximum amount of attention, this method is ineffective and does not result in the optimal distribution of attention among advertisers.

FEES

An alternative method would be to charge a certain fee for each unit of attention that is attracted. This way, if an attention attracting advertisement is worth more to one advertiser than to another, he could simply pay more fees. The difficulty with this method is how much to charge for one unit of attention. The correct fee would be equivalent to the costs that are induced to society. This value is very difficult to determine. Unfortunately a difference in attention that brings only little extra benefit to the advertiser may cause great costs to society, for example causing an accident. Thus, a small estimation error determining the fee could result in far to much advertisement and a big loss for society. Progressive fees that become more expensive the more advertisement is already there could partly compensate for this, but are also difficult to determine. Thus, in theory, fees could result in a optimum advertising amount for society, but are too difficult to handle.

TRADABLE CERTIFICATES

An approach that combines the advantages of maximum permissible values and fees are tradable certificates. In this approach, for each location in a city a certain amount of attention can be consumed, which is represented by certificates. These certificates are then sold in an auction, resulting in the advertiser valuing attention most getting the most of it. This approach is useful when the value of a good is different for different players but these values and the costs to society are unknown. Both conditions hold in our case. With tradable certificates we can be sure that no more attention is consumed that the amount of certificates we sold, and the distribution among advertisers is optimal.

The main problem with this approach is the high transaction costs in executing the auction, rendering the approach impracticable for current analog advertising schemes. With digital signage however, the auction could be executed automatically by software agents without any human intervention. When auctions are used to sell advertising space on digital signage anyway, auctioning the certificates would only add little complexity to the process.

AUCTIONING ADVERTISING SPACE

One promising approach for selling advertising space on digital signage are auctions. Depending on the context, advertisements bid different amounts to be shown. Such auctions have evolved as the predominant approach of selling advertising space on the Internet. Both big players in this field, Google and Yahoo, use second price auctions on keywords [1], where advertisements can bid to be shown when the user searches for a certain keyword. Even on the Internet, this bid can be different for different times of day or locations of the user. Because the advertisements are already tailored to the user, there is a relatively high probability that the user is really interested in the advertisement. Thus, the advertisements are usually designed relatively calm, mostly consisting only of a headline, a text block and a link. Because of its huge success in Internet advertising, it is quite probable that this approach will also become dominant in digital signage advertising. The process of auctioning advertising space for digital signage is depicted in figure 4. In analogy to Internet advertising, one hope would be that if the advertisements are tailored to the time, location and audience, they can be designed relatively calm.

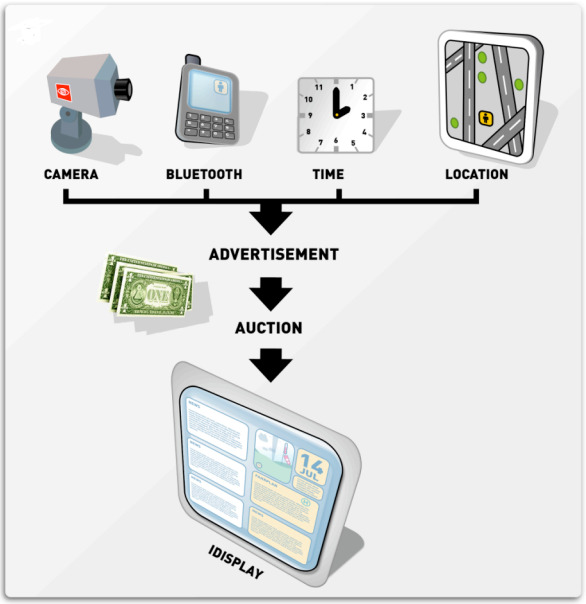

Figure 3: Auctioning advertising space on digital signage. At the start of each advertising cycle, context information is gathered from different sensors. This context information is then provided to the individual advertisements, which use it to generate their bids. In an auction, the available advertising slots are then sold to the highest bidders. For the duration of the advertising cycle, the selected advertisements are shown on the display.

AUCTIONING TRADABLE ATTENTION CERTIFICATES

If we accept that attention is a scarce resource where the costs of use should be internalized to the advertisers calculation, there would be two scarce resources that have to be distributed among advertisers: Advertising space and user attention. We present a first simple approach of an combined auctioning process for advertising space and public attention.

As a first step, public space would need to be subdivided into advertising regions. These regions should be of the right size such that in principle it does not matter where exactly within this region attention is consumed, as long as the total attention consumed within the region is below a certain level. This could be a crossing or a place, for example. Then, for each region, maybe depending on the

time of day, the maximum amount of attention consumed would be defined. According to this maximum amount, a corresponding number of certificates would be provided on a central server implementing the attention marketplace.

On each individual digital sign, advertisements would then bid for advertising space using the process depicted in figure 4. Once the space is distributed among the advertisements, the advertisements shown would then decide in which form they would present themselves. The same advertisement could show itself in black and white, color, with animations or as a movie, for example. To generate their bid, they could use a bidding strategy similar to the one for the auction for advertising space. Thus, advertisements would determine the utility of having themselves presented in a particular way and make the corresponding bids for attention certificates. One advertisement for example could have a high utility for being shown as a static image, but only a little higher utility for being shown as a movie. Another advertisement could have a low utility for being shown in black and white, but a high utility for being shown with animations. Then, the first advertisement would bid a lot for a few certificates, while bidding only little for more certificates. The second advertisement would bid the same high amount for as many certificates as necessary to present a movie. Once all bids are set, the central marketplace then sells the available amount of certificates and each advertisement is told how many certificates it bought. Each advertisement then selects the right way to present itself given the amount of attention it can consume, and the advertisements are shown on the displays.

CONCLUSION AND FUTURE WORK

In this paper, we proposed to model attention consumption of advertisements as a negative externality. We examined the methods of maximum permissible values, fees, and tradable certificates, to cope with the negative effects. We proposed to integrate auctions for tradable attention certificates with auctions for advertising slots on digital signage. This method allows us to implement tradable certificates with relatively low transaction costs. It enables us to define a maximum amount of attention that is consumed at a certain location at a certain time. It allows us to stay within these limits with minimum costs for advertisers.

We believe that controlling the amount of advertising in public spaces is an important challenge for science with huge effects on life quality in developed societies. We believe that our approach of auctioning tradable attention certificates has great potential to hold advertising in public spaces within bounds.

Important questions, some of which can be solved by the pervasive computing and ambient information systems community are:

1. How can technology support economic methods to cope with negative externalities in advertising?
2. How need combined auctions of advertising space and attention certificates be designed?
3. How can attention consumption be measured and how can attention certificates be designed?
4. Can the proposed techniques be transferred to other domains than advertising?

To conclude, we want to draw your attention to the central question of this paper, which we believe got far too little attention by the community up to now:

HOW CAN THE DIGITAL SIGNAGE ADVERTISING MARKET BE REGULATED SUCH THAT ATTENTION IS NOT OVERCONSUMED?

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