An Approach to Allocate Advertisement Slots for Banner Advertising

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ABSTRACT

In the banner advertising scenario, an advertiser aims to reach the maximum number of potential visitors and a publisher tries to meet the requests of increased number of advertisers to maximize the revenue. In the literature, a model was introduced to extract the knowledge of coverage patterns from transactional database. In this paper, we propose an ad slots allocation approach by extending the notion of coverage patterns to select distinct sets of ad slots to meet the requests of multiple advertisers. The preliminary experimental results on a real world dataset show that the proposed approach meets the requests of increased number of advertisers when compared with the baseline approach of allocation.

Categories and Subject Descriptors

H [**Information Systems**]: [Computational advertising]

Keywords

Internet monetization, Computational advertising, Banner advertising, Coverage patterns

1. INTRODUCTION

Banner advertising is one of the predominant modes of online advertising along with contextual and sponsored search advertising. The major stakeholders involved in banner advertising are advertiser, publisher and visitor. An advertiser expects a certain number of impressions for his/her banner advertisement. A publisher, who manages ad slots on web pages of the website allocates sets of ad slots to meet the requests of advertisers. A visitor visits the set of web pages and the corresponding ad slots. In the banner advertising scenario, an advertiser aims to reach the maximum number of visitors. A publisher aims to meet the requests of increased number of advertisers to maximize the revenue. Developing efficient approaches to help the publisher for managing available ad space by satisfying demands of more number of advertisers to maximize the revenue is the research issue.

In the literature [2, 3], the problem of display ad allocation was modeled as a bipartite graph and efforts were made to investigate ad allocation approaches that maximize the revenue using stochastic optimization methods. A model was introduced [4, 5] to extract the knowledge of coverage patterns from transactional database. Prioir work [2, 3] was focused on mathematical formulations of ad allocation, and approaches using clickstream database of a website have not been proposed.

In this paper, we exploit the notion of CPs and propose CPs based ad allocation approach which maps requests of advertisers and allocates appropriate CP to each advertiser.

The rest of the paper is organized as follows. In section 2, we provide overview of coverage patterns and in section 3, we present proposed approach. In section 4, we present the preliminary experiments. Conclusion and future work are presented in the last section of the paper.

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2. OVERVIEW OF COVERAGE PATTERNS

The notion of coverage patterns is explained in [4, 5]. In this section, we provide a brief overview of coverage patterns. A Coverage Pattern (CP) is a set of items that can cover a certain percentage of transactions in a transactional database. Given a transactional database, CPs can be extracted based on the threshold values specified for relative frequency, coverage support and overlap ratio parameters. Let $W = \{w_1, w_2, \cdots, w_n\}$ be a set of web pages and D be a set of transactions such that each transaction T is a set of web pages, $T \subseteq W$. X is a pattern of web pages such that $X \subseteq W$ and $X = \{w_p, \cdots, w_q, w_r\}$ where $1 \leq p \leq q \leq r \leq n$ and T^{w_i} denotes a set of transactions containing the web page w_i and its cardinality is denoted by $|T^{w_i}|$. We briefly explain the three parameters as follows.

- **Relative frequency:** The fraction of transactions containing the web page, w_i is called relative frequency of w_i. It is denoted by $RF(X)$.
- **Coverage support:** Coverage support of a pattern, X is the ratio of number of transactions containing atleast one item in X to the transactional database size, $|D|$ such that $|T^{w_p}| \geq \cdots \geq |T^{w_q}| \geq |T^{w_r}|$. It is denoted by $CS(X)$.
- **Overlap ratio:** Overlap ratio of a pattern, X, where $|T^{w_p}| \geq \cdots \geq |T^{w_q}| \geq |T^{w_r}|$, is the ratio of the number of transactions common in $X - \{w_r\}$ and $\{w_r\}$ to the

number of transactions in w_r (i.e., minimum number of transactions in either $X - \{w_r\}$ or $\{w_r\}$). It is denoted by $OR(X)$.

Let $minRF$, $minCS$ and $maxOR$ be the threshold values specified for RF, CS and OR parameters respectively to extract CPs. A pattern, X is said to be a CP, if $RF(w_i) \geq minRF$ where $w_i \in X$, $CS(X) \geq minCS$ and $OR(X) \leq maxOR$. An apriori-like algorithm, *CMINE* [5] is proposed to extract the complete set of CPs. An alternative approach named *CPPG* [5] is also proposed to extract the complete set of CPs efficiently.

3. PROPOSED APPROACH

Given a clickstream transactional database, CPs based allocation approach utilizes the knowledge of CPs to improve the ad allocation scenario. CPs are extracted from the clickstream transactional database by employing the *CPPG* algorithm [5] with the corresponding RF, CS and OR values. Advertisers request a certain number of impressions for his/her banner ad. Requested impressions are mapped to the extracted CPs. For each advertiser, an appropriate set of CPs that match the request are selected. Out of selected CPs that match the advertiser request, a CP which ensures more unique visits is allocated to the requested advertiser. The procedure repeats iteratively till no advertiser or no CP is left to allocate.

Table 1: Example transactional database

TID	Items	TID	Items
1	a, b, c	6	b, d
2	a, c, e	7	b, d
3	a, c, e, f	8	b, e, f
4	a, c, d	9	b, e, f
5	b, d	10	c, b, d

We explain the proposed approach on the example transactional database given in Table 1. Consider a set of three advertisers A_1, A_2, A_3 with requests of 8, 11 and 9 impressions respectively. The *CPPG*algorithm [5] is employed with parameters $RF = 0.3$, $CS = 0.4$ and $OR = 0.5$ on Table 1 to extract CPs. The patterns {c,f}: [$CS : 0.7$, $OR : 0.3$] and {d,f}: [$CS : 0.8$, $OR : 0.0$] both ensure 8 impressions with 7 and 8 unique visits respectively, maps to the request of A_1. Hence the CP, {d,f} which ensures more unique visits is allocated to A_1. Among the rest of the CPs, the patterns {b,a}: [$CS : 1.0$, $OR : 0.25$] and {b,e}: [$CS : 0.9$, $OR : 0.5$] ensure 11 impressions with 10 and 9 unique visits respectively, maps to the request of A_2. Hence the CP, {b,a} is allocated to A_2. The pattern {c,e}: [$CS : 0.7$, $OR : 0.5$] ensures 9 impressions with 7 unique visits, maps to the request of A_3 and hence allocated to A_3. The procedure terminates as no advertiser is left to allocate in the given example.

4. PRELIMINARY EXPERIMENTS

We conduct preliminary experiments on KOSARAK (KSK) dataset [1] which is an anonymized clickstream transactional database of a Hungarian news portal. As a baseline approach, we consider visit frequency (VF) based allocation where allocation is carried out based on the visit frequency

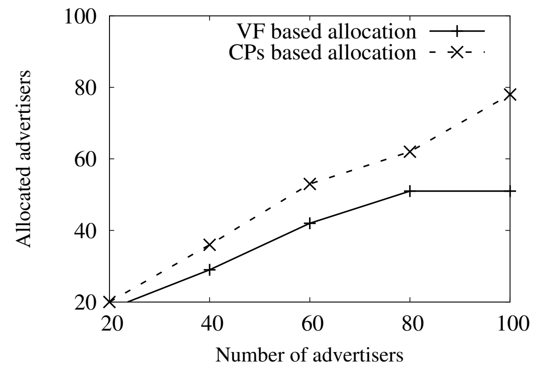

Figure 1: KSK: Allocated advertisers

of web pages which is calculated from the clickstream transactional database. Figure 1 shows the performance of allocated advertisers of the two approaches with respect to the number of advertisers on KSK dataset. From Figure 1, it can be observed that as the number of advertisers is increasing, CPs based allocation could allocate more number of advertisers when compared with the VF based allocation. This is due to the fact that the proposed approach allocates by exploiting the notion of coverage rather than arbitrarily combining the web pages for satisfying the requests as in VF based approach.

5. CONCLUSION AND FUTURE WORK

In this paper, we have proposed an allocation approach based on the knowledge of CPs which could improve the performance of banner ad allocation. The preliminary experimental results show that the proposed approach has potential to meet the requests of increased number of advertisers when compared with the baseline approach. As a part of future work, we plan to develop a robust ad allocation framework based on the proposed approach. Furthermore, we investigate various factors such as arrival order of advertisers, ad frequency etc., that contribute to maximize the revenue at the same time preserve the interests of visitors.

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