A Framework to Harvest Page Views of Web for Banner Advertising

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Abstract. Online advertising provides an opportunity for product sellers and service providers to reach customers and has become a key factor in the growth of economy. It is a major source of revenue for the major search engine and social networking sites. Search engine, context-specific and banner advertising are the major modes of online advertising. The banner advertisement mode has certain advantages over other modes of advertising. Currently, the number of websites registered comes to a billion. Each day, a typical website receives the number of visitors ranging from hundreds to millions. In a few years, the entire population of the globe is going to be connected to Internet and browse websites. It is possible for a product seller or service provider to reach every potential customer through banner advertising. In this paper, a framework is proposed to harvest the pages views of web by forming the clusters of similar websites. Rather than managing a single website, the publisher manages the aggregated advertising space of a collection of websites. As a result, the advertisement space could be expanded significantly and it will provide the opportunity for increased number of publishers to market the aggregated advertisement space of millions of websites to advertisers for reaching potential customers. It will also help in balancing the management of banner advertising market.

Keywords: Internet monetization · Computational advertising · Banner advertising · Internet marketing · Online advertising

1 Introduction

During the last decade, one could observe the rapid growth in the number of Internet users. In near future, one can expect that almost all population will be connected to Internet due to the reduction of connectivity and equipment costs. Due to the rapid expansion of the Internet, all the commercial activities are being shifted to online, and goods/service exchange through e-commerce is becoming the key driver of the economy. It is important to note that the cyber space allows constant visibility and accessibility to the products and services of business enterprises (seller) to the customer (buyer). In addition, the websites are available to the website visitors 24 hours a day.

The evolution of the Internet had a profound impact on the advertising domain. The Internet provides an untapped opportunity for the advertisers and has become an attractive medium for advertising. Online advertising, also called online marketing or Internet advertising, is as popular as other advertising domains like television and news papers. It is a form of marketing and advertising which uses the Internet to deliver promotional marketing messages to consumers. It includes email marketing, search engine marketing, social media marketing, many types of display advertising (including web banner advertising), and mobile advertising [3]. In online advertising scenario, the ever increasing website visitors are the potential customers for the advertiser. The interactive nature of the medium can be used by the advertisers to hold the attention of the customer. These take the form of advertisement placements either in response to users web search queries, or at predetermined ad slots on publishers web pages [11]. Over traditional advertising, online advertising has the advantages of faster diffusion of information and the absence of geographical constraints. It has become a key factor in the growth of economy in the Internet age. It is a major source of revenue for the major search engine and social network sites.

Currently, banner advertisement mode is the major form of web advertising in addition to the contextual and sponsored search advertising [20]. It is approximately a US $ 24 billion business [15]. A banner advertisement is described as a hypertext link that is associated with a box containing graphics which is redirected to a particular web page when a user clicks on the banner [6]. The Interactive Advertising Bureau developed standardized sizes and formats for banner ad placement [1]. A banner ad has become defined as a small graphical area on a web page, which include logos or messages to persuade the viewer to either click it or remember the brand advertised in a positive way. The banner advertisements can be in any form such as graphic images, animation, audio and video.

The following three entities are involved in banner advertising: advertiser, publisher and visitor. An advertiser is interested in endorsing products through banner advertisements. A publisher manages a website or an advertisement network that sells banner advertisement space. Finally, a visitor visits the web pages of a website which contains banners. Given budget constraints, an advertiser wants to advertise the products to the wider target audience segment which will result in enhanced sales. Given the ad slots, the objective of the publisher is to maximize the revenue by meeting the advertising demands of the maximum number of advertisers. A visitor is annoyed by the repeated display of banner advertisements. An advertisement should not infringe individual privacy. The publisher manages the advertisements.

The multiple issues concerning online banner advertising domain are as follows.

Auction mechanisms and charging schemes: The main challenge in auction mechanism design is the optimal allocation of advertising space for the multiple bids based on multiple factors. In addition, there is a complex problem of dealing with real time bids and dynamic advertising space for auction. Also, attracting

advertisers with a pricing scheme which results in the higher return on invest-
ment for the advertiser is the key challenge. There are multiple pricing schemes
offered by the publisher to charge fees for displaying the banner advertisement.
For instance, cost-per-thousand impressions (CPM) model, cost-perclick (CPC),
cost-per-event (CPE) model are the dominant models.

Scheduling and allocation of banner advertisements: Generally a website dis-
plays advertisements in consecutive time intervals and sells ad space to different
advertisers. Since the maximum space to be used by advertisements on a given
screen is always limited, the website owner may not be able to place all the adver-
tisements that are competing for space in a given planning horizon. In order to
maximize revenue, advertisements at a website should be scheduled optimally.
Also, many advertisements compete for space on a given web page in any given
scheduling horizon. Advertisements are updated at regular intervals of time and
a rectangular slot with advertisements is displayed in each interval. As a result,
each of these time intervals represents decisions to be made regarding which
advertisements to present to the viewer. Users should not be annoyed by multi-
ple display of the same advertisement. Also, the visitors to a website access the
site based on their information needs and individual interests. The key challenge
is to place the banner advertisement in an optimal manner to cover more target
visitors by matching the similarity of advertisement and user interests.

Privacy issues: Most of the targeted advertising systems are based on the
premise that the online behavior captures the user's interests. Tracking individ-
ual actions based on the online behavior is clearly infringement of individual
privacy. The challenge is to develop approaches without infringing the privacy
of the website visitors.

In addition to preceding research issues, we can also consider the building
of banner advertising frameworks to increase the availability of page views or
ad slots related to millions of websites as a research issue. In this paper, we
have made an effort to provide a framework to harvest page views of millions of
popular and unpopular websites. Currently, the number of websites hit a billion.
Seventy five percent of websites are not active. A new website is registered every
second [2]. Normally each of 25 million websites receives a certain number of
visitors ranging from hundreds to millions. Currently, publishers manage the
banner advertisement space of popular websites which receive a huge traffic.
Millions of websites receive number of visitors ranging from hundreds to tens of
thousands. The frameworks to manage the advertisement space of websites which
receive relatively less number of visitors have to be developed. In the proposed
framework, rather than managing the advertisement space of one single large site,
a publisher manages the aggregated advertisement space of several sites of the
similar category. So, the potential websites can be divided into clusters based on
the topic and the interested publishers can manage the aggregated advertisement
space of the cluster. As a result, there is an opportunity for the increased number
of publishers to play role in connecting the sellers with buyers. Due to expanded
advertising space, the products (or services) reach to large number of potential
buyers. It will balance the management of advertisement space and result into
the growth of the economy.

In the next section, we explain the related work. In Sect. 3, we explain the proposed framework. In Sect. 4, we discuss the design issues concerning to proposed framework. The last section contains summary and conclusions.

2   Related Work

We discuss the related work on the issues of banner advertising and website clustering.

In [23], a strategy was presented to model and predict the arrival and departure of users with Bluetooth enabled devices within an advertising system. It has been shown the performance of the bidding strategy proposed in that paper is better than the simple and randomized bidding strategies even in an uncertain environment. In [22], a mechanism was proposed under Cost Per Action (CPA) pricing model where the utility function of the advertisers is independent in an online advertising scenario. The proposed mechanism estimates the utility using sampling based learning algorithms and determines the pay based on the estimation. Florin Constatin et al. [11] proposed a model for auctioning ad slots in advance. In that work, the authors report the theoretical and practical problems pertaining to display advertising and study online pricing schemes where allocation decisions can be revoked with some cost. The solution proposed in [15] addresses the problem of trade-off in deciding which impressions to allocate to the guaranteed contract and which ones to the spot market for auction. Banner advertising has traditionally been sold via guaranteed contracts. A guaranteed contract is a deal between a publisher and an advertiser to allocate a certain number of impressions over a certain period, for a prespecified price per impression. However, as spot markets for banner advertisements, such as the Right Media Inc. [4] have grown in prominence, the selection of advertisements to show on a given page is increasingly being chosen based on price, using an auction [15].

Efforts are being made by Adler et al. [5] to solve scheduling problem by formulating as a standard bin packing problem. A greedy heuristic and random permutation technique was proposed to select and display subset of ads that fit an ad slot respectively to maximize the revenue. A Lagrangian decomposition method based approach has been proposed by Ali Amiri et al. [6] for scheduling of banner advertisements. Kumar et al. [20] proposed a genetic algorithm inspired from the standard multifit algorithm for the classic bin packing problem. In [19], a heuristic of Knapsack like problem is solved for every ad slot with an aim of maximizing expected revenue from K exposures of an ad with the specified constraints. The problem has also been studied by Nakamura et al. [21] as a linear programming problem. A variant of greedy algorithmic techniques to select the subset of advertisers that maximize the revenue is introduced in [13].

An approach to extract Coverage Patterns (CPs) from transactional dataset is proposed in [24]. Given a website clickstream transaction data over a period of time, the statistics of visitors behavior can be analyzed by processing the transactions. Set of web pages that can cover a certain percentage of transactions is called Coverage Pattern (CP). It was stated that the knowledge of CPs can be

used for the placement of the banner advertisements on the web pages. Improved approaches for extracting CPs is presented in [25, 26]. In [29], a model of content specific CPs and a methodology to extract content-specific CPs from clickstream data is proposed to capture the aspect of relevancy between the web pages and the banner ads to be displayed on the web pages. The notion of coverage and concept taxonomy has been employed by authors in [8] to group search keywords in the context of search engine advertising. The authors proposed an approach to advertise on the tail query keywords. A concept taxonomy was employed while creating the coverage patterns to ensure semantic relationships among the grouped keywords. Their results show considerable improvement with respect to utilization of advertisement space and achieved more diversity in capturing the eye balls for a particular advertisement.

To address the issue of targeted online banner advertising, a framework has been proposed in [14]. The approach is based on the idea of precisely targeting advertisements based on characteristics and behavior of individual users of information services. For example, visitors of a Travel page on an information service may be good targets for an advertisement for discount airfares, as would readers of the Travel section of a newspaper. Caruso et al. [9] proposed an approach for behavioral targeting using naive Bayesian model to maximize the profit by estimating the click frequency of banner advertisements. In [30], through experimental study on different strategies adopted by different advertising networks, the strategies adopted by different advertising networks such as *Taobao* and *AdSense* were discussed by considering the dataset from leading advertising network platforms and compare the strategies experimentally. It was shown that optimality of allocation depends primarily on platform targeting technology and demographical and categorical match of advertisements. In personalized systems, users long term activity is monitored. Many existing approaches to banner advertisement are based on demographic targeting or on information gained directly from the user. An approach for personalized web advertising has been proposed in [16]. It is based on knowledge extraction from the web pages content and historical user sessions as well as the current behavior of the online user, using data mining techniques.

In [10], the authors consider architecture of existing ad networks and present an online target advertising technique with a defined set of rules that ensure consumers privacy to avoid click frauds. Continuous monitoring of a users online habits, capturing and storing the data and linking with other databases is a privacy infringement. One of the aspects of privacy preserving advertising is not storing any data related to the web user on a long term basis. Kazienko et al. [16] propose an approach to address the issue of privacy preserving in banner advertising. The approach helps to capture immediate short-term user interests and select a suitable advertisement from the pool of available banners. An *AD ROSA* system has been proposed for an automatic web banner personalization, which integrates web usage and content mining techniques to minimize the user input and to respect the users privacy [17]. An experimental study has been conducted by Bleier et al. [7] on the effectiveness of retargeting technique for personalized banner advertising. The role of various factors like information and intrusive aspects

in the effectiveness of the click through rates of the banner ads depending on the web browsing behavior of the customers was discussed.

Some of the research efforts related to website clustering are as follows. In [12], attempts are made to identify websites as a group to extract interesting information which can be used in various applications. In that paper, they introduce a new approach of website mining with an idea of considering each website as a super page and applied several classification techniques to classify the super pages like normal web pages classification. In [28], computer implemented methods are introduced to automatically associate resources like websites with a group user at given point of time. They define an approach to group by considering frequently accessed group of websites within a time bound by a user and thus provide valuable information about a particular group of users accessing a particular group of websites. In [18], they attempt to use unsupervised machine learning techniques to cluster website group home pages to identify similarity aspects of home pages of different website groups. In that paper, the authors use self organizing maps and principal component analysis based clustering techniques and validate the reliability of the clusters obtained.

3   Proposed Approach

We first explain the related terms and discuss the existing framework. Next, we present the proposed framework.

3.1   Existing Framework

We explain the notions website, ad slot, adslot pattern and advertisement space.

– **Website:** The number of web pages in the website can range from one to millions. The website is a collection of pages owned by individual or organization. We consider a group of web page as the website, if the advertisement space of a collection of web pages and corresponding click stream data is owned by one entity.
– **Ad slot:** Regarding banner advertising, the unit of advertising space to place a banner on the web page is called banner advertising slot or more commonly referred as an ad slot. A web page may have several ad slots.
– **Ad slot Pattern (AP):** A set of ad slots is called ad slot pattern. Each Ap has certain number of expected page views.
– **Advertising space (AS):** Consider n web pages. The ad slots of n pages is called the advertising space of n pages. Similarly, the ad slots of all pages of website (or a set of websites) are called as AS of a website (or a collection of websites).

The advertiser, publisher and visitor are the main entities in banner advertising. An advertiser wants that the advertisement should be reached to the large number of visitors. The publisher who manages the advertisement space makes

efforts to maximize the revenue by covering the advertising requirements of as many advertisers as possible.

Normally, in the existing banner advertisement framework, a publisher manages the ad space for a single popular website or a collection of popular websites. The banner advertisement can be managed in a static manner in which the APs with certain number of page views are extracted and allocated to the advertiser and corresponding ads are placed in the ad slots. Also, the ads can be dynamically placed in the corresponding ad slot as and when a user clicks the corresponding web page. In this paper, we consider static framework to explain the existing and proposed framework.

The framework to manage AS of a website consists of two steps: Extraction of APs and Scheduling and allocation of APs. The framework is depicted in Fig. 1.

1. **Extraction of APs:** The input to this process is web pages and click stream data of the website. From the web pages, we know the web page id and available Ad slots. From click stream data, it is possible to extract the knowledge of APs concerning to the website. The output of this step is the sets of APs with the expected number of page views for each AP.
2. **Scheduling and allocation of APs:** Very large number of APs could be extracted from the AS of the website. Several advertisers put demand for advertisement space, such as number of page views with budget. The publisher follows appropriate scheduling and allocation strategy to maximize the revenue by allocating APs to advertisers.

The area of banner advertising is an active research area. Several approaches have been proposed in the literature (refer Related Work section) about the issues concerning auction mechanisms and charging schemes, scheduling and allocation of banner advertisements, methods to target customers, and privacy protection.

3.2   Proposed Framework

Currently about one billion websites are registered and 25 million websites are active [2]. Each website receives a certain number of visitors ranging from thousand to millions. For managing AS, normally, the publisher considers the popular
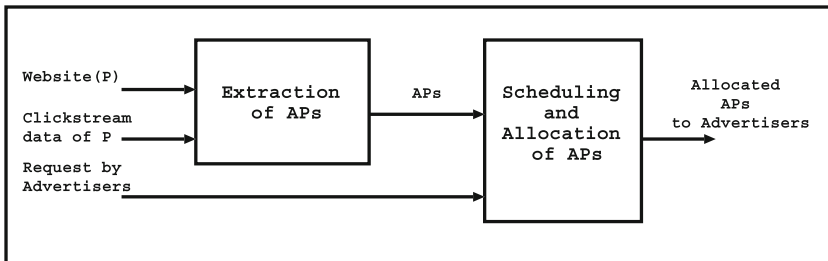

Fig. 1. Framework for managing the advertising space of a single website.

websites which contain a large number of web pages and receive huge traffic. It can be noted that millions of websites receive the number of visitors ranging from hundreds to tens of thousands. The frameworks to manage the advertisement space of websites who receive relatively less visitors have to be developed.

In near future, almost all the population is going to be connected to the Internet and spend time in browsing. We consider that every user who is connected to the Internet visits a certain number of websites, is the potential target for banner advertising. The main issue is to evolve an advertisement management framework which allows to exploit the page views of every user who is browsing the Web.

The basic idea is as follows. We can divide the websites into two groups: the websites which receive huge traffic and the websites which receive relatively less traffic. For example, a newspaper site is might be more popular and receive huge traffic as compared to the traffic received by the website of an educational institute. For banner advertising, the combined advertising space of several unpopular websites that receive relatively less traffic could be used to create potential AS similar to AS of the popular website. The main issue is to group the websites into meaningful clusters such that each cluster of websites receive certain type of traffic and provide AS which is marketable by a publisher. For example, a cluster of websites concerning medical educational institutions receive traffic consists of students, parents and teachers who are concerned to medical education and could become AS for promoting products related to pharmaceutical and medical domain.

We propose that it is possible to connect sellers with more potential buyers by providing a broad framework to harvest AS of Web by creating appropriate groups of websites. If we develop and operate frameworks to group the websites based on interests and enable thousands of publishers by assigning one or a few groups of websites to each publisher, it is possible to harvest page views of web to display ads. In the proposed framework, the publishers manage the AS of a cluster of websites of similar category. So, the potential websites can be divided into clusters based on the topic and the interested publishers can manage the advertisement space of a cluster of websites. As a result, there is an opportunity for increased number of publishers to play a role in connecting the sellers with buyers. As a result, the products or services reach to large number of potential buyers. It will also balance the management of banner advertisement space and accelerate the growth of the economy.

The proposed framework consists of four steps: Clustering of websites, Allocation of website clusters, Extraction of APs from a website cluster, and Scheduling and allocation of APs. These steps are depicted in Fig. 2.

1. **Clustering of websites:** The input to this step is a set of websites in a broad topic area. The module divides the websites into clusters. The websites are clustered based on the theme or topic. Each cluster contains the websites of the same theme or topic. For example, the websites of engineering educational institutes could be one cluster and the websites of medical educational institutes could be another cluster.
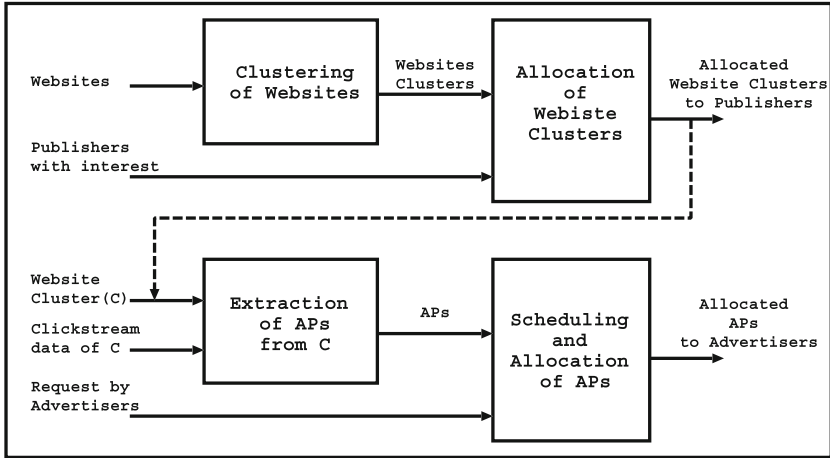
Fig. 2. Proposed framework for managing the advertising space of clusters of websites.

2. **Allocation of website clusters:** The input to this step is website clusters and publishers with interests. A publisher is willing to manage the advertisement space of a website cluster having specific interests. Based on the publishers' interests, the website clusters are allocated to publishers. For example, the websites of educational institutes provide a large user base which could be used to place the banner advertisements regarding educational programs.
3. **Extraction of APs from a website cluster:** In this step, the web pages and click stream data set of the websites of the cluster is processed, and the ad slot patterns are extracted with the expected number of views.
4. **Scheduling and allocation of APs:** Similar to the step 2 of the existing framework, the publisher follows appropriate scheduling and allocation strategy to maximize the revenue by allocating APs to advertisers.

4   Design Issues

We discuss the design issues by considering each step of the proposed framework. In the first step, the clusters of websites are formed. It requires the investigation of approaches for efficient clustering of websites such that each website cluster contains ad slots with a business potential so that a publisher could market advertisement space to advertisers with appropriate pricing strategy. The websites can be clustered based on the topics, demography, locality, types of business, profile of the users and so on. In the literature, research efforts are on to cluster the websites [12], associate a group of users to a set of websites [28] and identify clusters of similar home pages [18]. Scalable approaches are to be investigated to cluster millions of websites in an efficient manner.

Also, so far, publishers manage the advertisement space and provide services to advertisers. As, dividing a broad category of websites into several clusters

and assigning the advertisement space of each cluster to different publishers is another kind of advertisement management task. The enterprises which carry out such task can be called as Ad Cluster Managers (ACMs).

The second step is the allocation of website clusters to publishers. Based on the demand from several publishers, ACM should allocate website clusters by meeting the demands of as many publishers as possible. In the existing framework, several approaches have been employed to help the publisher to schedule and allocate the ad slots by meeting the demands of as many advertisers as possible. For the proposed framework, similar approaches have to be investigated to allow ACM to allocate website clusters to as many publishers as possible.

The third step is to extract APs by processing the clickstream data of websites of the cluster so that the APs could be used by publishers to meet the demands of the maximum number of advertisers. Web usage mining [27], is an active area of research, which is being used extract interesting patterns from clickstream data of e-Commerce website to understand the user behaviour and recommend the products to users. Currently, APs are extracted by processing click stream data of single website. For the proposed framework, appropriate approaches have to be investigated to extract APs by processing the clickstream data of several websites of the cluster.

The fourth step is to allocate APs. This step is similar to the step 2 of the existing framework. The approaches employed to schedule and allocate APs of the existing framework can be used. In the literature, efforts have been made to generate ad schedules using traditional linear optimization techniques [5,20,21], greedy techniques [13] and pattern mining techniques [24–26,29].

The issues regarding privacy are the major aspect in the proposed framework. In the existing framework, developing approaches to protect the privacy of user is an important research issue [17]. However, in the proposed framework, the clickstream data of several websites is available to ACMs. The websites clusters and APs are to be managed by protecting the privacy and business interests of individual websites.

5   Summary and Conclusions

In this paper, we have proposed a framework to harvest page views of Web for banner advertising. It is proposed that the advertisement space of several websites could be aggregated by clustering similar websites to provide banner advertisement services. The publisher manages the advertising space of a cluster of websites. As a result, in principle, the expanded advertisement space of all websites in the web could be harvested to reach customers. It will provide wider opportunity for the sellers to reach the potential buyers. Also, the proposed framework will provide opportunity to a large number of publishers to play a role in managing the advertising space which will balance the management of banner advertisement market.

The proposed framework opens-up several research problems. Approaches have to be developed to cluster the websites having similar target customers.

It has to be demonstrated that the page views of users who are accessing multiple websites could be aggregated to form a potential banner advertisement space which could be marketed to potential advertisers with appropriate pricing strategy. Efficient allocation of website clusters to publishers is another issue. Also, efficient approaches have to be developed for extracting ad slot patterns by processing click stream data of the multiple websites of the cluster. Efficient scheduling of advertisers' requests and efficient allocation of ad slot patterns extracted from cluster to advertisers are also research issues. Also, most important, the advertising space of multiple websites have to be managed by protecting the privacy and the business interests of the website owner.

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