

Evaluating Quality Score of New Web Advertisements

Thesis submitted in partial fulfillment of the requirements for the award of degree of

Master of Engineering
in
Computer Science and Engineering

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Certificate

I hereby certify that the work which is being presented in the thesis entitled, "*Evaluating Quality Score of New Web Advertisements*", in partial fulfillment of the requirements for the award of degree of Master of Engineering in *Computer Science and Engineering* submitted in Computer Science and Engineering Department of Thapar University, Patiala, is an authentic record of my own work carried out under the supervision of *Dr. Deepak Garg* and refers other researcher's work which are duly listed in the reference section.

The matter presented in the thesis has not been submitted for award of any other degree of this or any other University.


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This is to certify that the above statement made by the candidate is correct and true to the best of my knowledge.



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Abstract

Web advertisement is the one of the most profitable source of incomes for the search engine giants like Google, Bing, Yahoo and Baidu. According to Google, revenue obtained from web advertisement in 2012 is close to \$43billion which is 20% more than that of 2011[1]. Top notch search engine uses Generalized Second Price auction to calculate rank of ad and the bid amount to be paid by user. Rank of ad tells about the position of ad to be displayed on search engine result page. Probability of being clicked of an ad is heavily relied on the position at which it is displayed in search engine page and position of ad involves determining click through rate of ad. It can be calculated empirically for ads that have been displaying repeatedly. But in case of new ad it is very complex and challenging task as historical information of ad is not present. By using bid amount solely ad rank can't be calculated, as it will decrease the quality of ad, which is core aspect of web advertisement in search engine perspective. Quality of ad drastically affects the revenue of search engine which also results in un-satisfaction of user. In this thesis work we have designed a strategy to determine CTR of new ad by using various features of ad and landing page.

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List of Abbreviations

GSP-Generalized Second Price Auction

Ad- Advertisement

CTR- Click Through Rate

SERP- Search Engine Result Page

Web Ad- Web Advertisement

PPC-Pay Per Click

CPI- Cost Per Impression

Chapter 1

Introduction

This chapter contains introduction to online/web advertisements including its various types, and why web ad is necessary, how ads are displayed with organic result on search result page followed by organization of thesis.

1.1 Web Advertisement

Concept of web advertisement is taken from commercial advertisement done in print and electronic media. In web advertisement, ads are displayed on the web pages. There are various types of web advertisements like sponsored search advertising, contextual advertising, display advertising and banner ads [1]. But we have confined our work to sponsored search ad and used the pay per click (PPC) model. In pay per click model, advertiser pay after his ad is clicked. GSP (Generalized Second Price auction) is widely used technique by giant search engines like Google, Yahoo, and Bing. To know the details of GSP refer [2]. In GSP, CTR is vital parameter. Revenue of search engine is directly impacted by CTR. CTR is the ratio of number of times ad displayed to the number of time ad clicked. It is usually less than one. $CTR = 1$ is the ideal case. CTR plays crucial role in determining quality of ads.

Although there are dozens of parameters which are taken in consideration by search engine but Quality is the indispensable metric in GSP auction mechanism. Google, Yahoo uses GSP for determining cost per click and position of web ad on search engine result page (SERP). Indeed CTR is heavily depends on the position of ad. Probability of being clicked of Top most Ads is maximum and it decreases from top to bottom. Also search engine like Google display ads on the two positions: top most and on right side of SERP. Top most ads are more likely to get clicked than right most ads.

Owner of advertisement has to select some keywords for which his ad will be displayed. When the user hit the query search engine extracts the keywords from it. Then search engine selects ads which have given keywords. Now, search engine process all shortlisted ads and calculate parameters like CTR, keywords, relevance, bid amount, landing page quality and many more. Then according to policy of search engine it embeds the certain ads into search engine result page. Now, user will have option either to click on recommend ads or on links that are showing in SERP.

1.2 Impact of Web/Online Advertisement

From business to education and from marketing to media almost all fields has deep impact of web advertisements. Most important factors are given below:

1. Improvement in brand image
2. Increase in purchase of goods
3. Good exposure
4. Spreading accessibility among unexplored audience

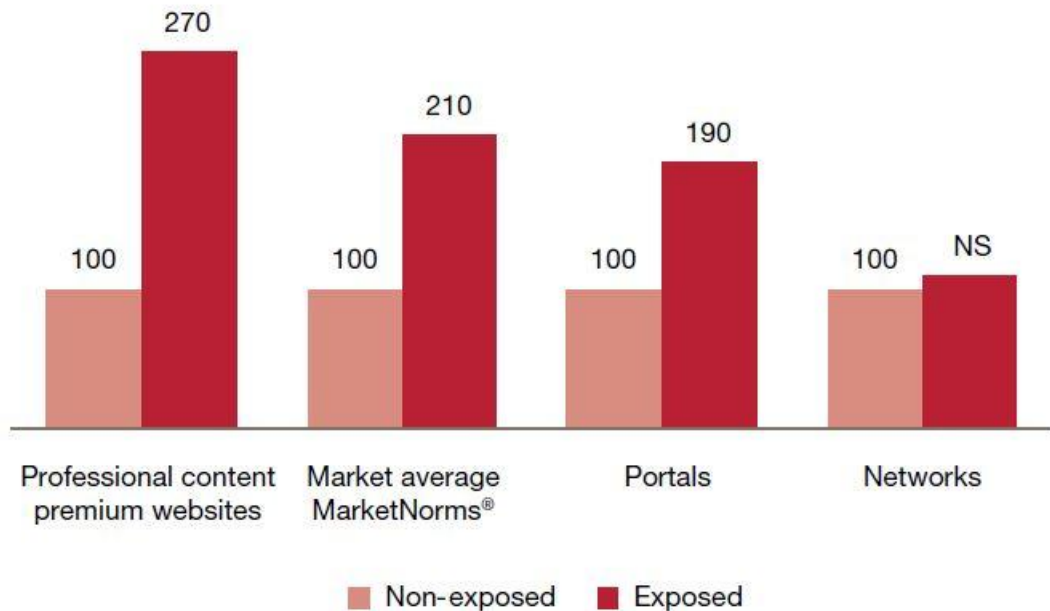


Figure 1.1: Exposed and Non Exposed Assets on Internet [3]

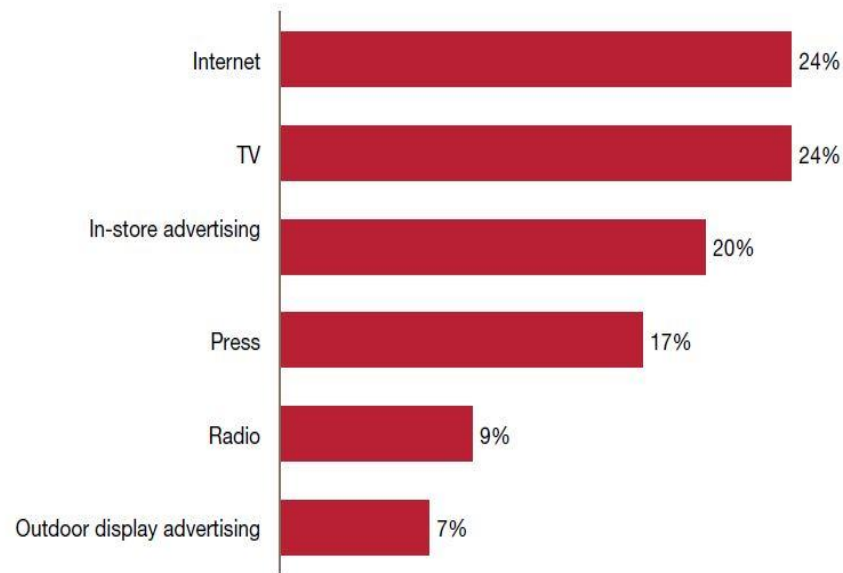


Figure 1.2: Impact of Advertisement on Media [3]

1.3 Types of Advertisement [4]

Advertisements are generally categorized as:

1. Cross-Media
2. Display
3. Search
4. Social
5. Video

A brief detail of every category is given below:

1.3.1 Cross-Media

Cross-media advertising is a strategy used by business owners to market a business using various types of media. Owners may use all of media types individually or combine several mediums to create a cohesive marketing campaign. Cross-media advertising is one often unnoticed by business owners, especially entrepreneurs. Cross media involve

use of opposite media for example ad related with print media should also be done in web.

1.3.2 Display

In display web advertisements, ads (text, logos, or images) are displayed on the web pages. Features of display ads are adopted in various different techniques. It is less relevance so it is now obsolete from web. [5]

1.3.3 Search

Whole search advertisement is based on the user's query. Words from query get matched with the keywords of advertisement then the ad will be considered for further processing. It comes in the picture only to target the match search terms entered by user on search engine. Our project is based on search advertisements. Given below are the categorization of web ads.

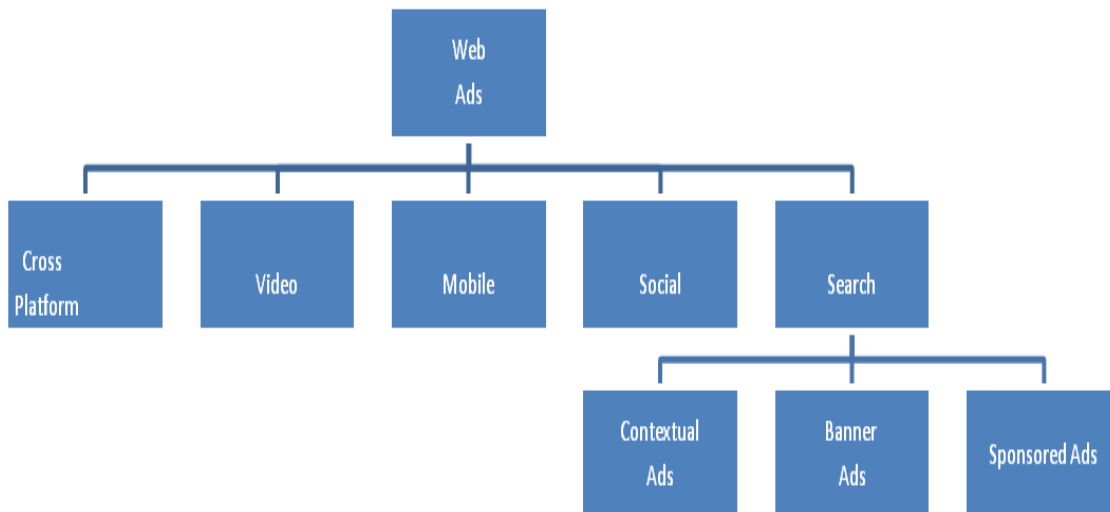


Figure 1.3: Categorization of Web Advertisements

1.4 Types of Targeting [6]

In this section various types of targeting is discussed using data collection methods. Targeting refers to considering particular type of customer for specific ads, like student community is more likely to fascinate by movies advertisements. So, by adding flavor of social media, advertisements can be made more effective and efficient. Some techniques are drawn from mass media. These techniques are behavioral targeting, geographic, demographic, affinity, contextual and behavioral targeting.

1.4.1 Demographic Targeting & Geographic Targeting

As its name suggesting that in geographic targeting, ads are presented to user on the basis of their geographic location. Often location are derived from IP address and read from cookie. Sometimes location also derived from profile details entered by user during registration.

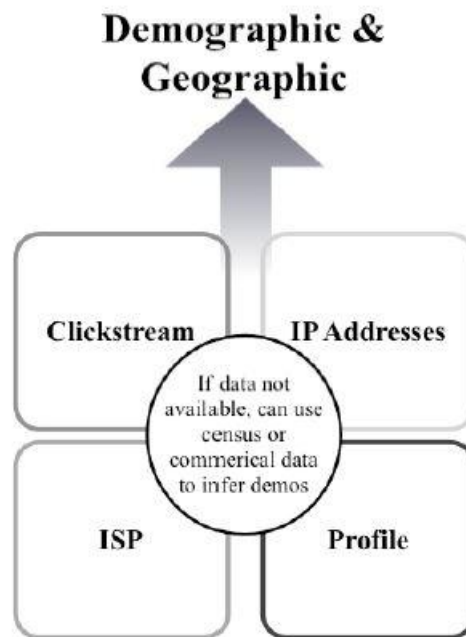


Figure 1.4: Demographic and Geographic Targeting [6]

In demographic targeting, ads are served on the basis of factors like gender, age, caste and creed. If data is not available then it can be infer from census data or online click

stream and also from data given by user. In Figure 1.4, sources of data are given for targeting purpose.

1.4.2 Contextual Targeting



Figure 1.5: Contextual Targeting [6]

Concept of Contextual targeting is derived from mass media. In this type of targeting ads that are complimentary to content are served. For example on travelling site, ads of airlines are served. To aid the user, such type of contextual advertising is used. Users are more likely to book ticket if he visited the travelling site. It does not require cookies or any user details. By just knowing website's keyword, ads can be placed. Main idea behind contextual advertising is to find the audience that is more likely to purchase complimentary items. On the other side in affinity targeting those ads are displayed which are similar with content. This type of targeting is existed in various forms before internet but was not able to gather crowd, or in terms of web advertisements unable to receive ample number of clicks.

1.4.3 Behavioral Targeting

Behavioral targeting is used to increase relevance of web advertising for user. For e.g. in case of shopping how many times user purchase particular item and number of colors sold are analyzed to increase the selling of goods. Basically there are two types of entry is possible: active entry and passive entry. Behavioral targeting is used to increase the relevance in web ads. It is purely done empirically i.e. after noticing and analyzing trends of user, purpose of ads is substantially increased. Figure 1.6 shows the growth of behavioral targeting industry. Year by year annual growth as well as expenses are increasing.

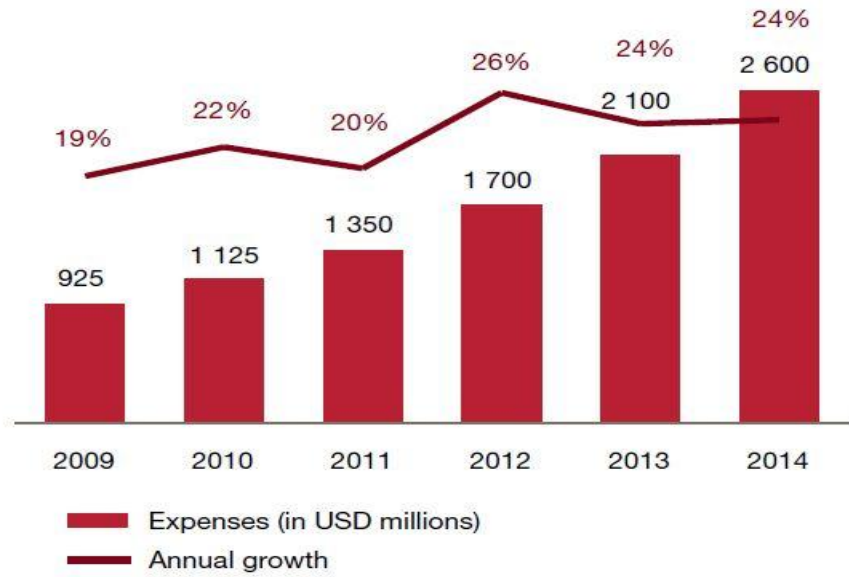


Figure 1.6: Growth of Behavioral Targeting Industry [3]

1.5 How Sponsored Ads are Displayed on the SERP

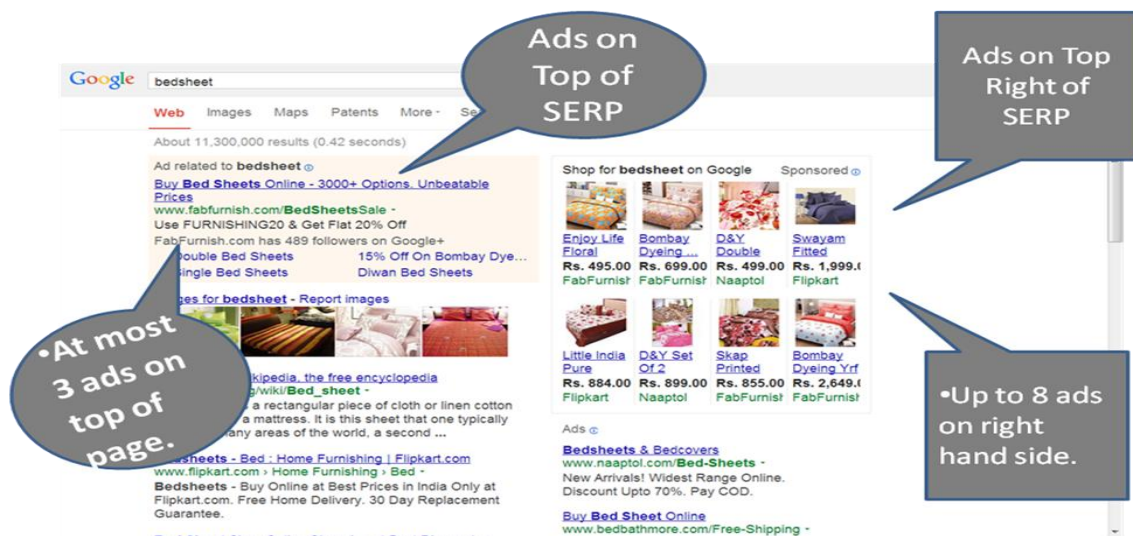


Figure 1.7: Sponsored Ads on Search Engine

Figure 1.7 shows how sponsored ads are displayed on search engine. Usually ads are displayed on top of search engine and right side of search engine. at most 3 ads are displayed on top of page and that of 8 ads on right hand side.

Example of sponsored link is given below. At the bottom, link is provided which is called landing page link. After clicking, page is redirected to landing page, where all details of ad are given. Above hyperlink, few words about ads are mentioned which captures user's attention.

[Top 100 New York Events](#)

Top NYC Events Listing Exclusively
at clubZone! Info, Tickets & VIP
www.clubZone.com/NewYork

Landing Page

1.6 Reasons for Web Advertisement

Basically there are two aspects of web advertisement: advertising agency and advertiser. Here scenario is same but terms are different. In case of web advertisement search engines play role of advertising agency and advertiser can be organization, individual or any one. First we have discussed web ad with respect to search engine followed by advertiser.

Search engines caters user by giving them proper result of their query. So, if search engine gives high quality (here, high quality refers to relevance and more informative) result then user will visit them again. Hence more the user uses the system more it will be popular which results in more business.

So, there are two reasons behind web advertisement in search engine perspective: revenue and relevance. Both are equally important but on focusing latter one former one will automatically get increased. Search engines like Google, focus more on relevance. Relevance itself is broad domain; so many parameters took part in making web page more relevance. Few parameters have been discussed latter. In short we can say Basically Web advertising is a business model to generate revenue for search engines and most important, providing relevance search result to user.

On the contrary to the search engine, advertiser has only one main motto, to increase the business or get more popularity. Advertiser wants to display their ad on well renowned search engine. Also it is a global platform to expand business round the globe. So, in

short web ads aid user in searching quality content. And we can say web ad is win-win situation for all three parties: search engine, advertiser and user.

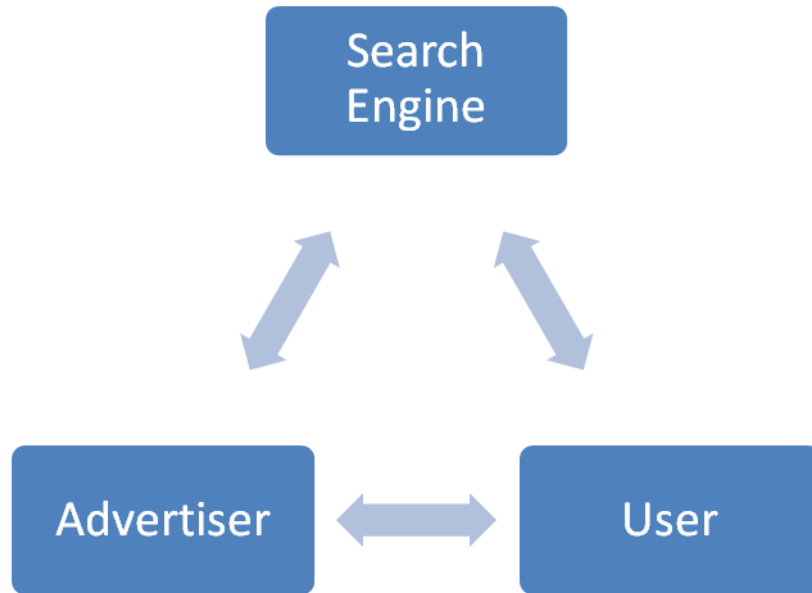


Figure 1.8: Relationship Between User, Search Engine and Advertiser

1.7 Difference Between Google Ad Sense and Ad Word

Google ad sense and ad word both are different way of advertising on web. Both have their own significance. Google ad sense is a technique used publisher. Publishers are those business enterprise or individual who owns the web site and give some space for advertisement. Search engine embeds ad on the site. In Google ad sense, search engine directly contacts and pays to publisher.

Google ad word counterpart of Google ad sense has little different functioning. In Google ad sense ads are not embedded in the web site of individual but ads are displayed on the search engine result page. In Google ad word advertiser selects some keywords for which their ad is going to display. When keyword get matched in user query, then there ad's certain parameter would be calculated and ad may get displayed on the result page.

In figure 1.9 given below, candidates ads are displayed for ‘Leather Chaise Lounge’

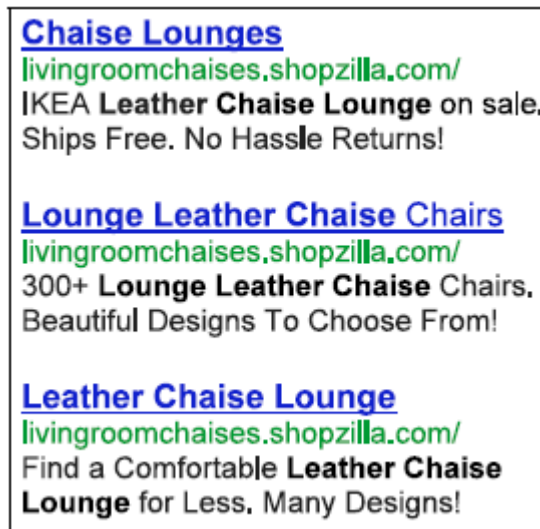


Figure 1.9: Sponsored Ads for Query Term [8]

1.8 Key Terms Used in Web Advertisement

Some prime key terms used in online advertisements are explained in this section.

1. Agency

An ad server is a web server dedicated to the delivery of advertisements. This specialization enables the tracking and management of advertising related metrics.

2. Ad networks

Ad networks provide an outsourced sales capability for publishers and a means to aggregate inventory and audiences from numerous sources in a single buying opportunity for media buyers.

3. A demand side platform (DSP)

It provides centralized and aggregated media buying from ad exchanges, ad networks and sell side platforms, often leveraging real-time bidding capabilities of these sources.

4. A sell side platform (SSP)

A sell side platform provides outsourced media selling (to DSPs or ad networks) and ad network management services for publishers; it does not provide services for advertisers.

1.9 Organization of Thesis

The rest of the thesis is organized as follows:

Chapter 2- This chapter contains exhaustive description of literature survey done to study the concept of secure auction, Generalized Second Price Auction, issues in New Advertisement.

Chapter 3- This chapter deals with problem which is addressed in thesis.

Chapter 4- This chapter focused on detailed solution of problem that is addressed in thesis. Some related concepts that are cardinal in our proposed method followed by implementation details.

Chapter 5- This chapter possesses measure of empirically calculated quality score parameters followed by comparative analysis with other approaches.

Chapter 6- In this chapter conclusion, followed by possible future research work is discussed.

Chapter 2

Literature Survey

This chapter contains exhaustive description of literature survey done to study the concept of secure auction, Generalized Second Price Auction, issues in New Advertisements.

2.1 New Web Advertisements

Hamed [2] proposed a prediction method to predict the quality scores of new ads. His proposed method finds existing ads that are semantically similar to the new ads. He estimates the quality scores of the new ads based on their corresponding similar ads and didn't use general features such as number of words in ad and type of URL of other existing ads in determining quality score. Method starts with finding similar ads, and followed by prediction quality score.

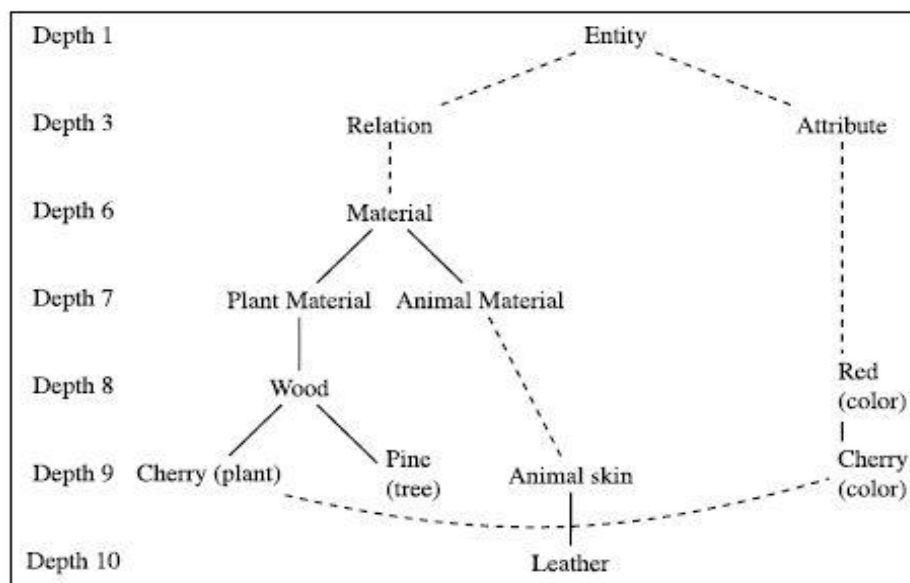


Figure 2.1: Tree of Terms in WorldNet [8]

In [9], Ashkan tried to estimate CTR through query intent analysis. They estimate CTR of ads with respect to history of ads and queries using a query. They focus on important factors that are very effective in determining click through rate. History of ads and queries are taken into the consideration, so they concentrate on general click through rate not only new ads. Average Click through rate for entire search result page given by search engine and count of ads that were displayed are the core foundation of their model. Model is tested on real life dataset taken from one of the top most search engine.

Richardson et al. [10] focuses their work towards new ads. Prediction model is built using stats of existing ads. They find global CTR for frequent and infrequent word. Frequent words are the words that have high CTR in specific periods. Also logs and clusters are used to find relationship between new terms and historical terms. They didn't consider the ads which has less than 100 views. They incorporate features from landing page and advertisement itself.

Work of [11] combines the essence of prediction and recommendation. They predicted click through rate for ads and recommended measures on how to improve quality of ad. Decision's rule is the foundation of given model. They worked on their own data set as they didn't have access to ads content and keywords. Logs are formed by aggregating all queries by user for which ad was displayed by search engine. Several features are extracted from the ads and logs of advertiser and decision rule is formed.

Advertisements are clustered on the basis of bid terms then using logs of particular cluster click to determine click through rate [12]. But [10] stated that cluster brings large variation in performance of top ads. So, they incorporate all the features of ad.

To make the campaign semi automatic, keywords are recommended from landing page. Only those keywords are proposed that don't lies in landing page. By increasing bid, ads can't get position on the search engine but it is not sure that it results in high conversion rate. So, keywords too play important role in generating revenue [13]. They tested there model by performing blind testing experiments on real world data and made more clear distinction.

Work of [14] is slightly different from others. Their core area is also predicting ad click through rate but they deeply focus their work on performance metrics like performance analysis, computation, predictions which is not given much importance by others. Work is based on unsupervised learning. They give a vivid description between theoretical and practical aspects of work that has been done in a given domain. Challenges that are faced in deploying a system are also elaborated with a deep insight view. By using the model of [12] some recommendations related with length of title, keywords selection can be done to users in order to bring more quality to ads which in turn decreases the cost per click and enhances coverage area.

In [15], the author tried to estimate the performance of an ad group in sponsored search. In estimation model analysis the author checks several parameters like latent bias, Interactive Influence, Feature Model (FM), convergence check, loss function, Position Correlation Analysis.

Work related to GSP is explained in [16], generalized second price auction is explained under uncertainty. In uncertainty bidding price of the winner gets higher than contract price. In this situation, profit becomes negative hence advertiser never makes a contract.

In current keyword auctions, the number of displayed slots (advertisements) is determined in advance. In [17], authors adjust the number of slots dynamically based on the bids. For example, if one bidder has a very high valuation per click compared to other bidders, she is allowed to exclusively display her advertisement as long as she is willing to pay a premium. In this case, we can simultaneously obtain better social surplus as well as better revenue for the seller (the search engine). We investigate a flexible keyword auction protocol that can dynamically adjust the number of slots. To this problem setting, we can apply the well-known Vickrey-Clarke-Groves (VCG) protocol, which is guaranteed to satisfy strategy-proofness and Pareto efficiency.

However, as pointed out in [18][19][4][11], several difficulties exist when using the VCG in practice. In keyword auction setting, one serious limitation for using the VCG is that seller's revenue can be lower than the GSP, discouraging search engines from

introducing the VCG. Determining the VCG payment is also quite complicated and not intuitive. Thus, bidders have difficulty understanding this protocol and more simple protocol than the VCG should be developed.

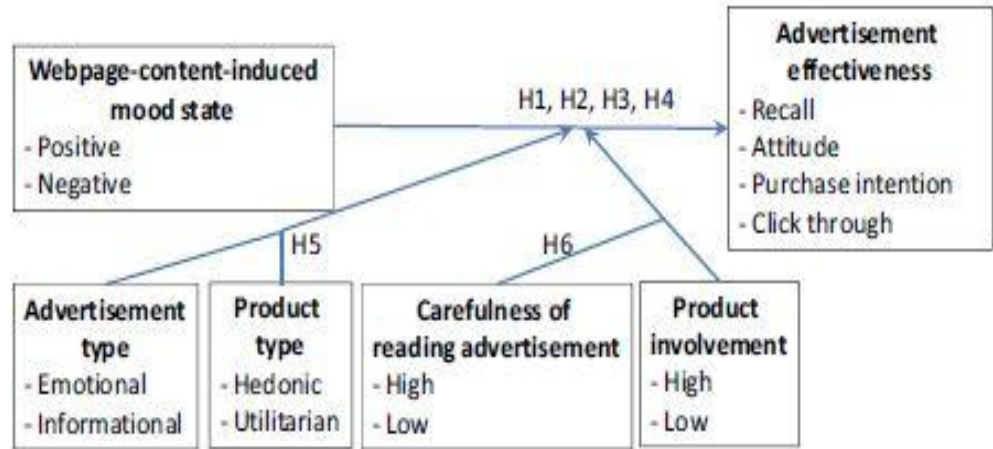


Figure 2.2: Framework for Evaluating Parameters [20]

We would like to add some more papers that are indirectly related to our approach. Reference [20] paid more focus on effectiveness of advertisements; they proposed a new parameter which is also responsible for number of click ads received that parameter is mood of customers. They hypothesize that customer with positive mood tend to click more on advertisements than that of negative mood ad. Effectiveness of ad is affected by mood of customer. In Figure 2.2 given above, several parameters are considered in order to study variations in click through rate. Every parameter has some predefined value out of all one is assigned at a time. Parameter like product type, ad type, product involvement, carefulness of reading, involvement of ads and mood have two value while effectiveness of advertisement has four values.

2.2 Secure Auction

Another strand of work which is based on the secure keyword auction is [21] unlike all strategy, a secure mechanism is proposed in which bidding prices and CTRs are not made public in calculating winners and their payment. Use of cryptographic techniques alone

can't make the auction secure so new payment rule is proposed in-order to prevent the leaking of bidding prices.

2.3 Sponsored Search Auction Mechanisms

In [22], a model is proposed for multiple keyword auction based on the generalized second price auction and its equilibrium is analyzed. Two important aspects are point out and they are: A. Substitutive Property of Keyword and B. Difference of Keywords. In former one keywords are substituted with their most common semantic similar words while in latter one difference of keywords are find out and accordingly ads are displayed.

In [23], author coined a different term position auction for sponsored search auction. Problem is addressed with the perspective of user. To make the user more profitable an optimal tender price is calculated. When advertisement is clicked, owner of advertisement i.e. advertiser is charged an amount that is equivalent to tender price of advertiser of below rank. So, some changes are done in Generalized Second price auction. And new term coined which is called position auction.

A framework is explained in [24] which models sponsored search auction. Two existing mechanism (GSP and VCG) is elaborated in this mentioned research work. A new mechanism is derived for sponsored search auction which is named as OPT (optimal mechanism). Revenue generated by OPT mechanism is computed and compared with other two mechanism and OPT mechanism is shown better with more revenue and Bayesian incentive is achieved.

Parameters like reservation price, number of slots, quality for bidder and parameter for k-th position is kept secret from advertiser and only auction results consisting of payments and winners are open to public.

In GSP, advertiser whose ad is going to display on the web page pays always less than bidding amount, in generalize form kth highest bidder pays:

$$p^{(k)} = \frac{q^{(k+1)}b^{(k+1)}}{q^{(k)}}. \quad (1)$$

Where, $p^{(k)}$ is the price to be paid by k^{th} highest bidder, $q^{(k+1)}$ is the quality score of $k+1^{\text{th}}$ bidder and $b^{(k+1)}$ is the quality score of $k+1^{\text{th}}$ bidder. In case of VCG, k^{th} highest bidding price is:

$$p^{(k)} = \frac{1}{C_k q^{(k)}} \left\{ \sum_{j=k}^K C_j q^{(j+1)} b^{(j+1)} - \sum_{j=k+1}^K C_j q^{(j)} b^{(j)} \right\} \quad (2)$$

So, by knowing other auctioneer's payment, bidding price can be determined. Proposed mechanism has two goals: one, mechanism has simple payment rule and other one bidding details shouldn't be leaked out.

In case of OPT (optimal) mechanism, price to be paid by k^{th} advertiser is given as:

$$p^{(k)} = \frac{q^{(k+1)}b^{(k+1)} + q^{(k+2)}b^{(k+2)}}{2q^{(k)}}. \quad (3)$$

Probability of Winning in Position Auction

In position auction, probability of winning of advertiser highly depends on the ad rank generated by generalized second price auction. In Generalized second price auction, ad rank is computed with the help of bid value and quality score. User can state bid value according to his budget but it is not the sole parameter which makes the ad rank higher. There is indispensable parameter which is known as quality score. Former is composed of three components, landing page quality, click through rate and loading time. Broadly, click through rate plays very crucial role in determining quality, which is explained earlier in section 1.

Assumptions in position auction

Based on the assumption in Friedman's model, the assumption in the position auction is formulated as following.

- 1) Targets of advertisers are to maximize their income
- 2) Information related with previous tender price can be offer
- 3) Distribution function is followed in each position of winner's tender prices.
- 4) Tender price of all advertisers are independent.
- 5) To maximize their expected income, bidders give their bid.
- 7) The information related with bidder' previous prices can be offered
- 8) Advertiser can bid irrespective of their counterpart
- 9) Each competitor's tender price can be seen as random sample distribution.

2.4 Metering Schemes in Sponsored Search Auction

Another related work that is focused on metering scheme is proposed in [25]. Authors address the issue of unfairness in metering scheme. Both the party i.e. advertiser and search engine suffers heavily due to unfairness in transactions. Both fears about variations in payment, advertiser fear about inflation in metering while web server fears about forged witness from an advertiser. Even in either of situations payment is unfair. Hence to address this issue, a web metering scheme is proposed for all type of environment. In mentioned scheme, advertiser can use intelligent devices to obtain services round the clock and from any place. Two techniques are used in mentioned scheme: hashing chain and other one is Shamir's secret scheme. Mentioned scheme is divided into four phases which are the interaction phase, the beginning of time frame phase, and the end of time frame phase, initialization phase.

2.5 Role of Cost of Advertisement in Sponsored Search

Another line of work that is closely related to ours is due to [26], where author focuses on the value of advertisements and relations among advertisements. In GSP, cost of advertisements is not considered, albeit it should be considered to generate more revenue.

Author tries to simulate the effects. Effects are defined from other advertisement. In case of two ads X and Y , an effect from advertisement X for advertisement Y is shown as $Y_{after} = Y_{before} + \alpha(X_{after} - X_{before})$. As same as this, an effect from advertisement Y for advertisement X is shown as $X_{after} = X_{before} + \alpha(Y_{after} - Y_{before})$. Value of α is $0 \leq \alpha \leq 1$. Some assumptions like number of advertisements, number of available slots, bid value lies in uniform distribution and number of click in one time are taken in this simulation.

Queries on major Web search engines produce complex result pages, primarily composed of two types of information: organic results, that is, short descriptions and links to relevant Web pages, and sponsored search results, the small textual advertisements often displayed above or to the right of the organic results. Strategies for optimizing each type of result in isolation and the consequent user reaction have been extensively studied; however, the interplay between these two complementary sources of information has been ignored, a situation we aim to change.

Findings indicate that their perceived relative usefulness (as evidenced by user clicks) depends on the nature of the query. Specically, we found that for navigational queries there is a clear competition between ads and organic results, while for non- navigational queries this competition turns into synergy. We also investigate the relationship between the perceived usefulness of the ads and their textual similarity to the organic results, and propose a model that formalizes this relationship. To this end, we introduce the notion of responsive ads, which directly address the user's information need, and incidental ads, which are only tangentially related to that need. Our findings support the hypothesis that in the case of navigational queries, which are usually fully satisfied by the top organic result, incidental ads are perceived as more valuable than responsive ads, which are likely to be duplicative. On the other hand, in the case of non-navigational queries, incidental ads are perceived as less beneficial, possibly because they diverge too far from the actual user need.

[27] too focuses on GSP auction, unlike all other work, authors does not assume that advertisements are mutually independent. Here mutual independent means each ad affect ad. And also value of ad is considered in mentioned approach. Authors postulated that

value of ad should be considered as it substantially affects bid amount. Comparison among GSP, VCG and stated approach. Figure 2.3 given below shows concept behind mentioned approach.

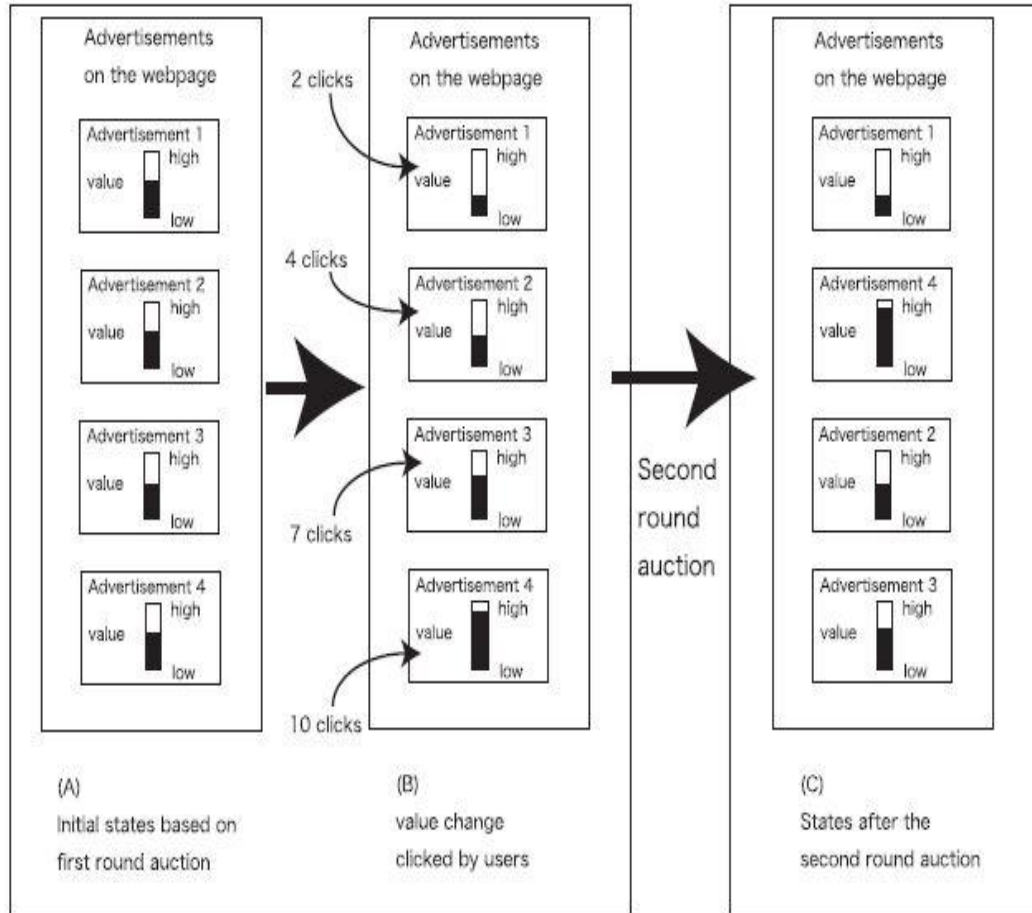


Figure 2.3: Value Based Analysis

2.6 Auction in Banner Advertisement

In another related work [28], the authors focus on banner advertisements which plays crucial role in revenue of advertisements. Scheduling of banner ad is intractable. In banner ads customer provides the number of copies to be displayed. So, the author tried to give good scheduling technique to schedule banner ads in given period of time.

Unlike all other work done in this domain, slightly different issue is addressed by [29]. Main emphasis is placed on format of advertisement. In order to make design of online advertisement efficient, ads and web site should be simple. It has been found empirically that to get best result multiple columns should be employed. Work is only confined to desktop system and in future work they would tried to extend their work to PDAs, and mobile devices.

Chapter 3

Problem Statement

With the advancement in technology, need to please customer is also increased. Role of advertisement is shifted from earning money to aiding customer. Online advertisement is win-win situation for search engine, advertiser and user. In search engine perspective revenue is motivating factor to provide ads, on the other hand for advertiser it carries long list of advantages and finally in the perspective of user, they are done with the task in less time and in more fruitful way. So, it is the responsibility of search engine to deliver quality ad.

In sponsored search, ads are displayed along with organic result on search engine result page. Ads with higher ad-rank are selected. Ad-rank of ads is computed from quality score and bid amount. Quality score of ad depends on several parameters like CTR, quality of landing page. But CTR is indispensable in all parameters. It is the fraction of number of times ad clicked to the number of times ad displayed. For old advertisements that are competing for long time, it is easy to get measure of CTR as previous details about their performance is available but in case of new ads, it is very difficult to compute as no historic information is available. So, the problem of determining Quality score of new ads is addressed in our work.

Details of Research Work

This chapter contains detailed solution of problem that is addressed in previous chapter, followed by details and some related concepts that are consider in our proposed method.

4.1 Introduction

In this work we are more focused towards new advertisements. New advertisements are the advertisements that are going to be displayed very first time. It is the rank of ad which determines which ad will be displayed and where (position on search engine page). Our strategy is based on Google ad words and is using pay per click as payment model. Rank of ad is calculated using GSP which is discussed in upcoming section. In GSP, CTR is essential parameter. For advertisements that have been displayed for long time, CTR is easy to calculate empirically from historic information of ad. But for new ad it is slightly difficult to compute as no previous information is available. So, in our work we tried to show for new ads, we have to go one step ahead.

To ensure quality of web page, we have traversed web pages entirely and computed the various parameters (discussed in following section) which aid in evaluating realistic CTR.

4.2 Ad Rank

Ad rank is given by Google the well renowned search engine. But latter on it was also used by Yahoo and Bing with slightly modifications. Google uses GSP (Generalized Second Price Auction) to calculate the bidding amount to be paid by advertiser. GSP uses the pay per click model in which advertiser pays on the basis of clicks. In GSP, advertiser submits bids to search engine to display its advertisement. But the actual amount paid by advertiser is less than what he bided. Ads are displayed on the basis of ad rank calculated by GSP.

$$Ad-Rank = Quality\ Score * Bid\ Quality\ Score \quad (4) [9]$$

And Quality Score is computed on the ad, landing page, keywords, URL and many more.

Quality Score Components: [30]

1. CTR (Click through rate)

- CTR is indispensable parameter in determining the quality score of any ad.
- CTR is the ratio of number of times ad is clicked to the number of times ad is displayed on the search engine result page.
- Generally, CTR is very less than 1 and ideally it is 1

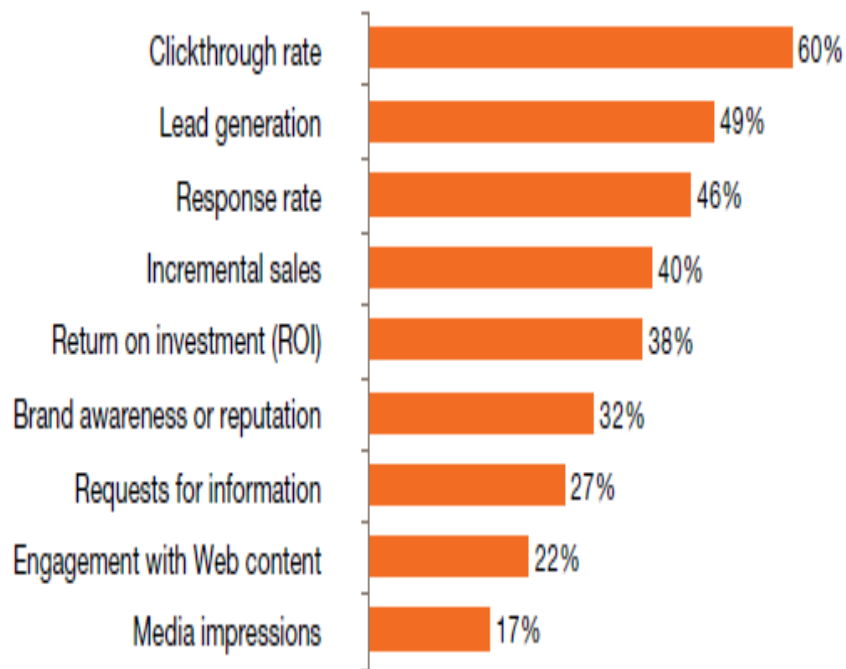


Figure 4.1: Indicators Used in Measuring Performance of Ads [3]

Figure 4.1 shows various indicators used by advertiser to measure the performance of online marketing campaign. CTR is most trustable parameter as it has been used by 60% advertiser followed by lead generation and least trustable is a media impression which is succeeding in gaining faith of just 17% advertiser.

2. Relevance:

- Relevance is the second most important metric in determining quality of ad.
- Relevance is related with the user satisfaction.

3. Landing Page Quality:

When user clicks on the ad, it redirect to web page (web site), this page is called landing page.

Quality landing page has the following properties:

- Structured
- Have all keywords
- No pop-ups
- Fast loading time

$$P_a * Q_a = B_{a+1} * Q_{a+1} \quad (5)$$

$$P_a = B_{a+1} * (Q_{a+1}) / Q_a \quad (6)$$

Where,

P_a - price to be paid by i^{th} advertiser

Q_a - quality score of i^{th} advertiser

B_{a+1} – bid amount of $i+1^{\text{th}}$ advertiser

Q_{a+1} - quality score of $i+1^{\text{th}}$ advertiser

So, in Google ad rank, actual bidding is calculated by using the quality score and bid amount of immediate next advertiser. If quality score is more and bid amount is less than also ad can be displayed on the other hand if bid amount is more but quality is poor then there is no chance of displaying ad. That is why Google is so focused towards the quality. Hence advertiser always pays less than his actual bidding amount. That is the beauty of Google ad rank. Due to this advertiser bids high because they knew they would have to pay less. And, search engine will get more revenue.

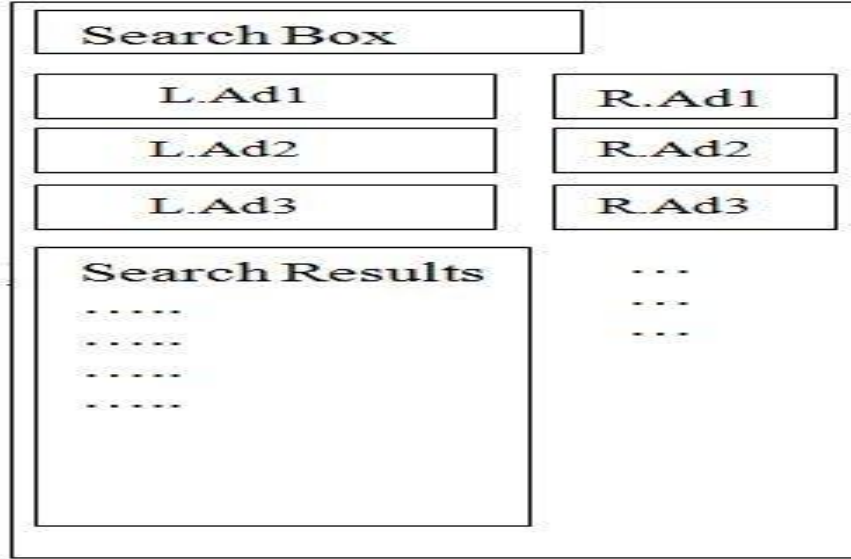


Figure 4.2: Layout of Search Page of Titan Search Engines

Advertisements slots are very few, as shown in Figure 4.2 L.Ad_i is the ads that display just below the search box. R.Ad_j is the ad that is shown on right most side of search engine. Count of L.Ad_i is shown as

$$c.l = \sum_{i=0}^{\varphi} L.Ad_i \quad (7)$$

Where, c.l is the number of ads on left side of search engine and ads on right side of search engine is given as:

$$c.r = \sum_{j=0}^{\rho} R.Ad_j \quad (8)$$

Where, φ and ρ are not fixed and depends on various parameter like damping factor, bid amount and total number of advertisers, explained in coming section.

It is not essential that ads would be displayed on every query. It all starts with user's query. It might be possible that on particular query one ad A_i is displayed on the top while on the same query same ad A_i displayed on the last position. So, it can be concluded that GSP auction processes for every user query; advertiser can change their bid amount in-order to retain best position [13].

$$B_a \geq B_{aa} \quad (9)$$

Here B_a is bid amount that is provided to search engine to get a place on the result page, while B_{aa} is the actual amount which is generally less than bid amount.

4.3 Relationship Between Position of Ad and CTR

Position of ad on search engine has lot to do with CTR as well as to the revenue. It is found that CTR of ad decreases drastically with the position of ad. Ad with top most position has 50% probability to be clicked and it get decreased to 40%, 30%, 20%, and 20% at the 2nd 3rd 4th position respectively.

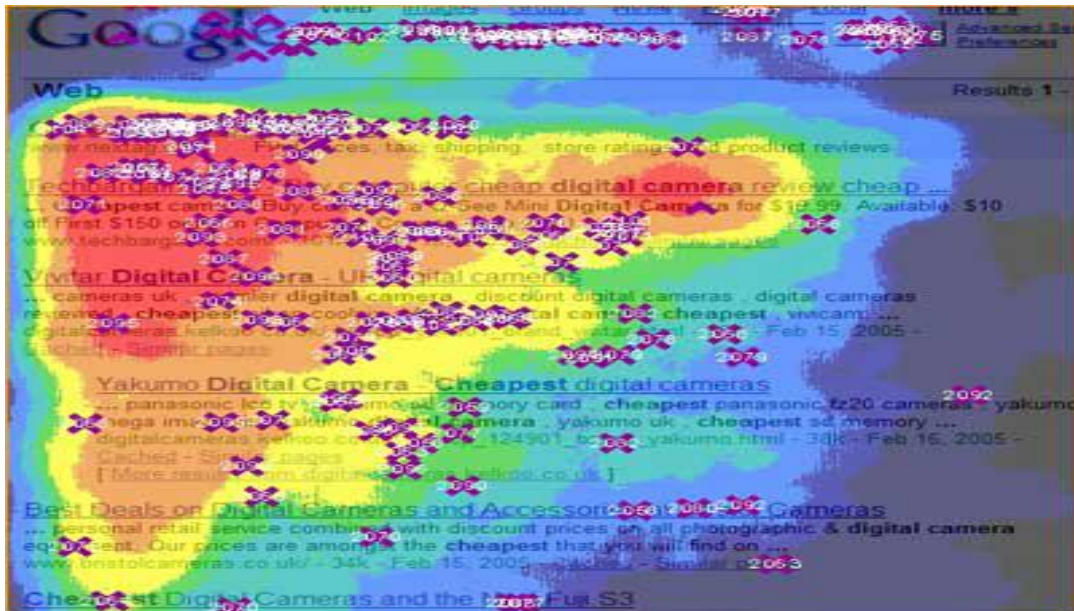


Figure 4.3: Heat Map Showing Most Watched Area on SERP [31]

4.4 Dataset & Technology Used

We have downloaded data set from which is made for web ad researcher.

- Size of data set is 512MB
- 7500+ web pages are considered for crawling

Technology Used:

- Python 2.7
- Apache Server 2.2

4.5 Steps to Calculate the Quality Score of New Ad

1. Extract words W_i from user's query where $1 \leq i \leq 20$
2. Remove stop words (pronouns, auxiliary verbs) from query
3. Make a cluster C_k of all advertisers whose keywords matched with the query words (Cluster can be of any size).
4. Process all web pages WP_i in cluster C_k , for every web page perform steps given below:
 - a. Check words from query in title of web page.
 - b. Count the occurrence of query words in keywords of web page
 - c. Check whether query word comes in anchor tag
 - d. Count the number of anchor tags in web page
 - e. Count the number of lines in web page
5. Certain value is fixed for every step, so sum up the values, this sum is called Quality Score.
6. Compute the ad rank as done in GSP mechanism and stored it in list along with web page URL (to uniquely identify it).
7. Now, we have multidimensional list consisting of web page URL and ad rank. Sort the whole list in descending order with respect to ad rank.
8. Now, once again employ GSP and find out the actual amount to be paid by bidder.
9. Pick top eight ads. Embed 3 ads on top left of the search engine page and remaining on top to down on right side on search engine web page.

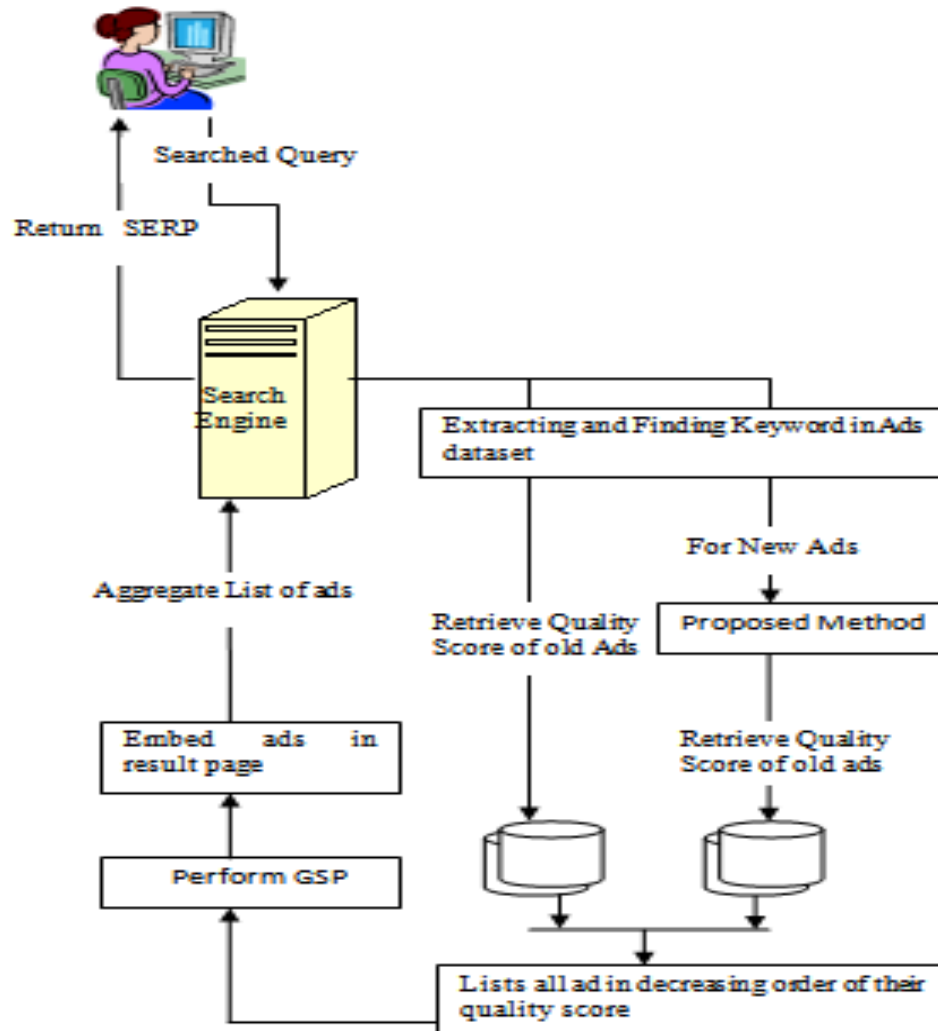


Figure 4.4: Block Diagram of Proposed Method

User enters query in search engine, keywords from query are extracted and matched with the advertiser’s keywords. If keywords get matched then matched advertisement are extracted from all advertisements. It may possible that for different search same advertisement’s is selected this all depends on the keywords given by advertiser. If advertiser’s advertisement is going to display very first time then proposed method is executed. Quality score of old ad is pre-computed by evaluating click through rate and quality of ad. In case of new ad by evaluating parameters it can be computed. Then all new and old ads are combined in descending order of their quality score followed by

performing GSP auction. And according to their ad-rank ads are embedded in search engine result page

4.6 Detailed Explanation of Component of Proposed Method

Here, we have tried to elucidate every component of proposed method in a more crystal clear way:

1) Extracting and Finding Keyword in Ads Dataset

User enters query in search engine and expect some results. First and foremost query is fragmented into words. Thereupon stop words are removed from fragmented words. Now, remaining words are searched into database of search engine. For advertisement there is separate database where all keywords of ads are stored. So, words from query are searched into ad database and matched ads are retrieved.

2) Retrieve Quality Score of Old Ads and New Ad

Basically there are two types of ads that are a part of system: Old ads that are in system for long time, performance related historical information of these ads is available. So it's very easy to calculate quality score of these ads. Usually search engine precomputes this information. In case of new ads, no historical information is available. Basically new ads are the ads that are going to display very first time. So, in this case proposed method is processed, which calculates the quality score of news ads in simplified way.

3) Merge List in Descending Order

After retrieving both quality score of new ads and old ads, both lists are merged in descending order. As most of the search engine focuses on quality, so on the basis of quality, sorting is performed. And top few ads remain intact while others are discarded. Count of these ads varies from search engine to search engine.

4) Perform GSP

In GSP, ad rank is calculated with the help of bid amount. Bid amount is one of the important metric in calculating ad rank. So, after performing GSP, lists of advertisements are sorted in descending order. Reason behind this sorting is equation 1, 2, 3.

5) Embed Ads in Result Page

This is the last step that is performed in system; ads are embedded into search engine result page and send to user. Here number of ads embedded in result page varies from search engine to search engine and also on the quality of advertisements. In short there is no fixed value for number of advertisements.

4.7 List of Parameters

This section comprised of explanation of parameters that are considered in calculating quality score of new ad. These parameters help in calculating quality score of new ad as well as aid in making web page of good quality. Here web page of good quality is the web page that has the high probability of getting clicked. Some most important parameters are stated below. Almost all parameters are somewhat related to keywords of web page. In brief, keywords are crux of web page because they tell a lot about web page and advertisement. Keywords are decided by advertiser, and if words from users query get matched with keywords then that ad is eligible to be processed in auction. For e.g. in advertisement of laptop, generally advertiser would select keywords as: cheap laptop, second hand laptop, light weight laptop, latest laptop etc.

1) Matching of Title(α)

This is most important parameter which tells a lot about quality of landing page. It refers to matching of keywords of web page to the title of web page. Positive value of this parameter signifies about good quality of web page.

2) URL of Landing Page(β)

When advertisement is clicked it is redirected to some other page that has more details about advertisement. This web page is called landing page. If keyword occurs in URL of landing page then that page is of high quality. Landing page contains all keywords that advertiser provide to search engine.

- 3) Ratio of count of keywords matched in title to the total number of words in title (γ)

This metric is enhanced version of first parameter, here ratio is calculated. Although ratio is always less than 1 but higher magnitude is desirable.

- 4) Length of ad (Ω)

Length of ad play vital role in evaluation of quality of web page. It is found that smaller ad is more focused, relevant and of more quality [13].

- 5) Number of keywords matched (λ)

This parameter is slightly different from above one. Here whole web page is traversed and keywords are checked. And count is maintained. Naturally, more is the desirable.

- 6) Count of anchor tags (η)

Count of number of anchor tag has good role in determining quality of web page. Because more the number of anchor tag greater will be the probability of redirecting to another page.

- 7) Count of matched keywords in anchor tag (σ)

Here occurrence of keywords in anchor tag is maintained. If keywords lie in anchor tag then it means redirect page belongs to same domain.

- 8) Length of Landing page (ς)

Length of landing page refers to number of lines it has. Quality of web page is more likely to get affected by value of more value of ς . We have empirically found out the most appropriate value of these parameters for ad of good quality.

4.8 Assumptions

- i. Value of bid varies from 1 to 10 \$
- ii. We have formed a cluster of same web pages containing laptop.
- iii. Number of bidder is always more than slots available on search engine.
- iv. Strategy based on Pay Per Click (PPC) Payment model.

4.9 Factors Included in Determining Position of Advertisement

There are so many factors that are being considered by giant search engines like Google, yahoo, Bing. Value is attached with every factor. After summing all the factors we will get estimated click through rate. Some vital factors have been listed in tabular form, with which we can get approximate result.

Table 4.1: Parameters of Quality Score With Their Measure

Factors	Value
Whole Query matching	20
Query's keywords matched in URL	10
Keywords matched in title of web page	12
Bidding Amount	10
Number of times Query's keywords occur in landing page	Count * .75
Finding query words in title.	12
Number of Lines in web pages	Lines * .02
Number of Anchor tag	Tag Count * 0.2
Ratio of number of words in query to the stop words in query	5

We have empirically found out the most appropriate value of these parameters for ad of good quality. Here multiplier is the value with which count of particular parameter is multiplied.

$$Q.S = \sum ((\alpha, \beta, \gamma, \Omega, \lambda, \eta, \sigma, \varsigma) * (\sum_{i=1}^9 \mathcal{E})) \quad (10)$$

Where, \mathcal{E}_i is the value of i^{th} parameter. Q.S is the quality score of advertisement which would require in calculating ad rank using GSP. Damping factor (ω) is added in quality score, as GSP converges on Locally Envy Free equilibrium [14][30]. Relative difference is computed to measure change in CTR in both cases:

$$\Delta_{(q_i, \alpha_i)} = \frac{|\text{CTR}_i^{\text{W}} - \text{CTR}_i^{\text{S}}|}{\text{CTR}_i^{\text{W}}} \quad (11)$$

$$\omega = \begin{cases} 0, & \Delta < \xi \\ \Delta, & \Delta \geq \xi \end{cases} \quad (12)$$

Where Δ is the relative difference of CTRs, where CTR_i^{W} is the CTR on whole data while CTR_i^{S} is the CTR on sampled data and ξ is the threshold value.

Damping factor is ignored if relative difference is less than threshold while damping factor will be equal to relative difference when threshold is less than relative difference [31].

4.10 Limitations

1. Small Data Set

Basically web advertisement is done on huge data. So, by taking small data set, results can't be asserted.

2. Centralized

Almost all algorithms that are being used in web yield good result only when they are implemented on distributed system.

3. No historical Information of Web advertiser

We don't have historical information of advertiser, which is very crucial in determining click through rate. And this is one of the biggest limitations of our project.

Experimental Results & Analysis

This chapter narrates how proposed technique outperforms by comparing with other techniques followed by snapshots of GUI on which search is being performed.

Values of parameters are computed on data set and normalized value has been found out by calculating average. Figure 5.1 represents normalized value of every parameter. Here, shaded value is desirable value that quality web page should possess. All parameters are mentioned on the x-axis while their value is taken on y axis. Range of value is from 0 to 0.4.

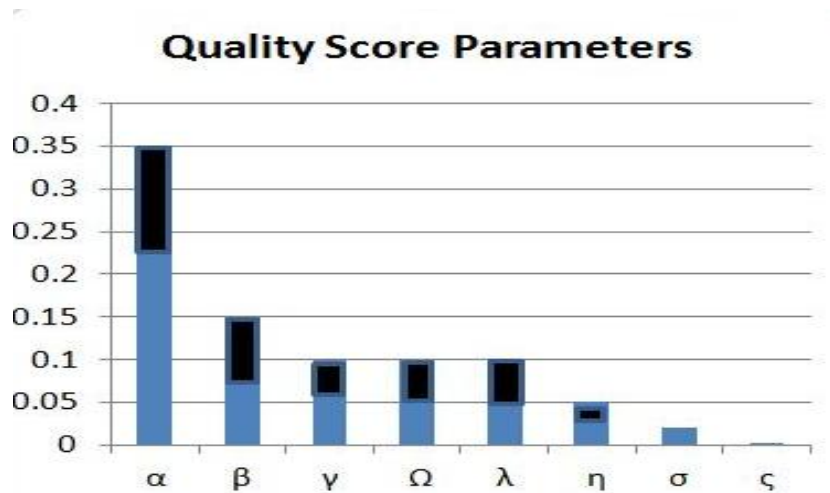


Figure 5.1: Range of Parameters

Table 5.1 shows the comparison of randomly chosen web pages and values of quality score of both the method is mentioned in respective cell, to bring more fairness bid amount is kept same for both the approaches. It has been found that given approaches performs in case of new ads.

Table 5.1: Comparative Analysis of Bid Amount and Ad Rank

	Bid Amount	Quality Score
Proposed Method	5	.457
	7	.524
	9	.599
Semantic and feature based model	5	.413
	7	.512
	9	.577

In subsequent Figure 5.2 result is shown for large datasets, which itself reveal about efficiency of proposed method.

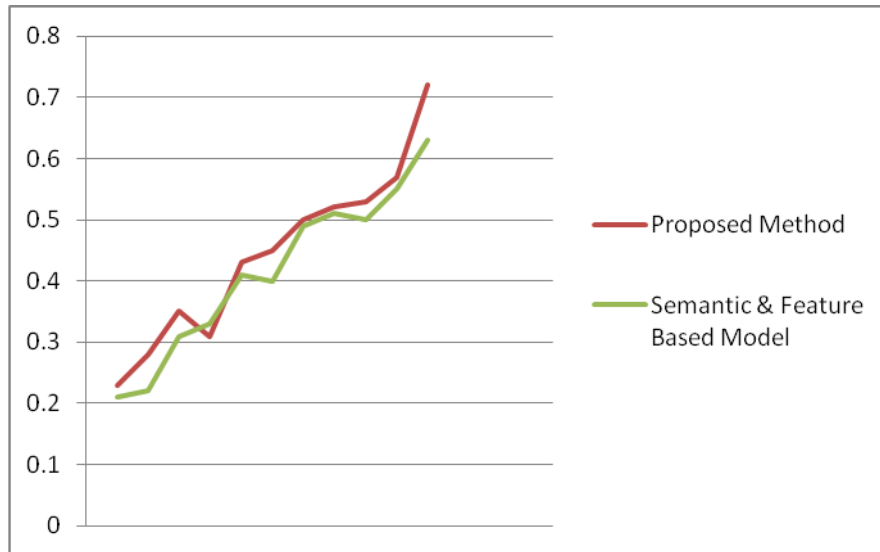
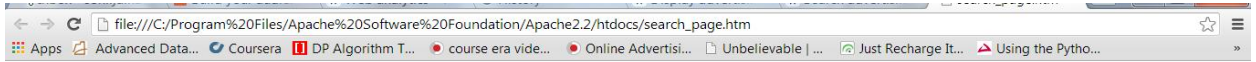


Figure 5.2: Comparative Analysis

Figure 5.2 shows the comparison done on the randomly picked advertisements from large pool of ads. For the same bid amount quality score is generated and arranged in tabular format. From the table, it can be deduced that given approach also performs satisfactorily on the random inputs.

5.1 Snapshots

1. Home Page



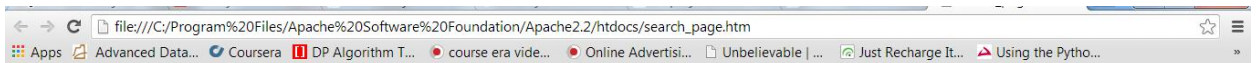
Web Ads^{©hil}

Search



2. Users Enters the Query

User enters query and then clicked on the search button

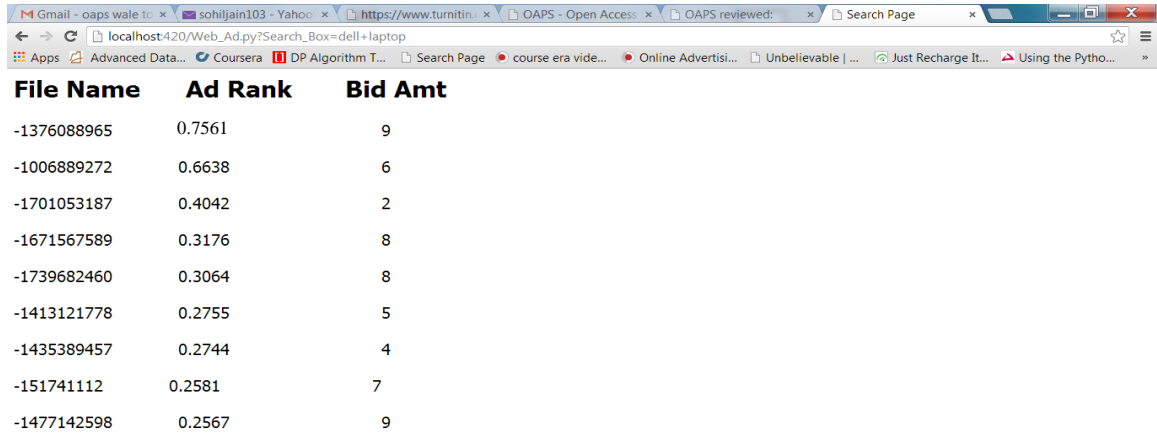


Web Ads^{©hil}

Search

3. Generation of Results

User enters query and then clicked on the search button



The screenshot shows a web browser window with multiple tabs. The active tab is titled 'Search Page' and displays a table with three columns: 'File Name', 'Ad Rank', and 'Bid Amt'. The table contains nine rows of data. The browser's address bar shows the URL 'localhost:420/Web_Ad.py?Search_Box=dell+laptop'. The browser's taskbar at the bottom shows several open applications, including 'Advanced Data...', 'Coursera', 'DP Algorithm T...', 'Search Page', 'course era vide...', 'Online Advertisi...', 'Unbelievable | ...', 'Just Recharge It...', and 'Using the Pytho...'.

File Name	Ad Rank	Bid Amt
-1376088965	0.7561	9
-1006889272	0.6638	6
-1701053187	0.4042	2
-1671567589	0.3176	8
-1739682460	0.3064	8
-1413121778	0.2755	5
-1435389457	0.2744	4
-151741112	0.2581	7
-1477142598	0.2567	9

Figure 5.4: Calculation of Ad Rank

Conclusion and Future Work

In this chapter work done in thesis is concluded and followed by clear vision of future work that will be taken further.

6.1 Conclusion

We have studied several techniques for determining click through rate of ads; they have their own pros and cons. But no particular technique is applicable for all type of applications. In case of ads that are competing for long time, it's easy to calculate quality score but for new ads it is very challenging task to determine quality score.

Several parameters are considered related to advertiser's advertisement and landing page. And their approximate value is also calculated empirically. It has been found that given approach evaluate quality score of new ads in very simplified way and also it performs in less space compared to that of other recent approaches in literature.

6.2 Future Work

In future work it would be more desirable to use standard data sets and tools which help in easy and absolute comparison with other technique. In order to get effective result we will try to implement our algorithm on distributed system with big data set. We will also include more factors like history of related advertiser and pre processing of web pages so that Quality score of new ad can be computed effectively.

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List of Publications

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