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Application of Grey Wolf Optimizer for optimal placement of web advertisements

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Abstract*: This paper throws enough exposure to reliable and optimal placement of advertisement by applying a nature inspired optimization technique. The grey-wolf optimizer helps us in determining how to assign web pages with relevant advertisements. Relevancy may increase by fine tuning the factors based on which our proposed mechanism is developed. We have taken into account fire major factors depending on which the optimizer is modeled. Later in this paper we have presented the robustness of each of this factor and how they influence the percentage of relevancy of advertisement placement

***Keywords* : Grey Wolf ,Optimizer, Web, Advertisement**

I. INTRODUCTION

The mechanism of finding best inputs so as to maximise or minimizing the value of output within a given constraint is termed as optimization. Whenever the constraints , other factors of the objective function one in hand , the optimization process starts. This area is more complex as sometimes a single objective function is not sufficient thereby forcing the need to develop multi-objective functions. Satisfying a multi-objective function is complex needless to say. The suitability of the algorithm to find the best solution to the objective function mainly depends on feature set of the objective function. The optimization techniques used traditionally includes gradient search or direct search method for the best solution. Nature based optimisation algorithm are modeled minimizing the behavior of animals in nature. There are already many such algorithms in use. In this paper we use one the popular metaheuristic techniques to take a decision on the placement of advertisements in web pages. As we all know the internet has a huge platform for advertisements and for engineers who act as web administrators for complex web pages. The task of optimizing the placement of advertisement becomes difficult. Advertisers observe the no. of times a person views or clicks on an advertisement for measuring the effectiveness of developing a contract. For the website administrator the intention is to maximise the number of visits of the advertisements on the server. Our paper considers many real time factors how the advertisements can be placed with minimum loss in the web traffic.

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The grey wolves hunting behavior . if we consider the food chain , the grey wolf is at the top of the hierarchy. The

"Alpha" wolf is the leader of the pack. It takes almost all decisions. Next in-line is "Beta" which supports alpha.

Beta replaces alpha if something happens to alpha. "Delta" and "Omega" are the lowest 2 levels where Delta has slightly more power than omega and omega submits itself to others in the hierarchy.

The grey wolf hunting has 3stages which are

i. Tracking
ii. Chasing
iii. Attacking the prey.

Our paper will use this behavior of grey wolf for finding a suitable web page on the server on which the advertisement will be placed.

II. PROPOSED MECHANISM

When in web pages , advertisements are to be placed numerous factors are considered. Below factors are highly considerable while making an optimal decision regarding the scheduling of advertisements on a web page.

I. **Access Rate Distribution in a web page(ARD) :** In a website under consideration , few web pages are visited more frequently than other pages in the same website. Hence , the placement of advertisements on such frequently visited web pages will bring more profit .

II. **Fairness(FR) :** There should e a balance between over exposure of advertisements. A optimal mix of advertisements is needed.

III. **Time Of The Day(TM):** To enhance the effectiveness of advertisements placement based on time of the day is also to be considered in our proposed mechanism.

IV. **Classification Of Content(CC):** The advertisement should be conclusive to the content of the web page. For instance advertisements of the sports related events will not be suitable on a astronomy-related web page. For avoiding such in appropriateness , schemes like keyword-matching , statistical forecasting methods are used currently. Our proposed mechanism will also exploit the benefits of the above mentioned methods.

V. **IP Address Attraction Ratio(IPAR):** This ratio is defined as no. of web pages visited with advertisements on a single IP address. This ratio gives by placement of advertisements on domains IPAR is relatively high.

A. Hierarchal Advertisement Placement:

In our proposed mechanism , we formulate the placement of advertisement on a web page as hunting by the pack of grey wolves. We represent the best fit to the solution i.e; placing an advertisement on a web page as "ALPHA"(α). Next best solution is given by "BETA"(β) and "DELTA"(δ). So , α,β,δ control the placement of the advertisement. The "OMEGA"(ω) follows these rule followed by α,β,δ.

B. Prey Encircling:

The wolves find a prey and encircle it. In our algorithm, a web page is found and decision has to be made whether advertisement should be placed on it or not. Following equation represents the current situation:

$$|\vec{M}.\vec{X_P}(t)-\vec{X}(t)| \quad (1)$$

$$\vec{X}(t+1)=\vec{X_P}(t)-\vec{N}.\vec{D} \quad (2)$$

't' represents current iteration ; 'N,M' are coefficient vectors of the web page, 'X' is position of 'α'; X_p is the position of the webpage.

The a linearly decreases from 2 to 0 over course of iteration and r_1,r_2 are random vectors having values ranging from 0 to 1.As 'α' is the best candidate with highest level of knowledge, β,δ too update their values accordingly.

C. Prey Attack:

The web page which gives highest 'α' value will be assigned the advertisement to it. 'α' sets a limit for β,δ to locate the set of webpages to place an advertisement. The 'α' value should reduce from 2 to 0 which makes it nearer to the prey. In our case as 'α' decreases from 2 to 0 the allocation of a advertisement also increases to a specific web page.

D. Prey Search:

$\vec{N}$ is used as $\vec{N}$ >1 or $\vec{N}$<-1; to represent the search agent to either diverge or converge from the prey(web page). If N >1; then the advertisement should move away from a web page and vice-versa. Our algorithm can search globally. The entire process of search is initiated when any possible location of the web page were estimated and over each iteration, the position and distance of the advertisement to a web page is updated. Until β,δ,ω have reached the optimal values after 'α' reaches the optimal value, the algorithm is repeated. It will terminate only when all the wolves have obtained satisfaction. In our case, only when β,δ,ω have reached a value nearer to 0 then we can stop our process. We can then assign the advertisement to that web pages. Every advertisement will have a value which is sum of effectiveness values of the factors we have considered while assigning advertisements on a web page.

$$\alpha = ard + fr + T_m + C_c + Tpar \quad (3)$$

(5 factors, so more weight-age)

$$\beta = ard + T_m + Ipar \quad (4)$$

(3 factors are considered, so medium weightage)

$$\delta = ard \quad (5)$$

(only one factor is considered, so low weightage)

III. EXPERIMENTAL STUDIES

We have considered 10 advertisements to be placed in websites which were created using Google. For validation of our proposed mechanism we created 5 websites. Out of these 5 websites, three websites were identified to place 6 advertisements based on our factors like ARD, FR, TM, CC, IPAR. We found that using all this factors together in first iteration, 7 advertisements were placed in our intended 3 websites. The other two websites carried rest three advertisements. Consequently we can conclude that **α** gives highest effective value for assigning advertisements on a web page. For next setup of the experiment we considered only the 3 factors ARD, TM, IPAR. We found that 4 of the advertisements were assigned in 3 of the websites. The remaining of 6 advertisements were placed in other two websites. For final observation we found that only 2 out of 10 advertisements were placed as intended in 3 websites and rest 8 advertisements were assigned to the other 2 websites. We construct the below table from derived observations.

Table I. Values for α, β, δ

Hierarchal Factor	% Relevancy of Advertisement placed
α	70%
β	40%
δ	20%

With more iterations for **β, δ** we can reach value of **α.** Instead if we fine tune the factors considered for calculation of **α** then we can enhance the relevancy ratio of **α** to more than 85%. For this to happen, highest effort should be to increase value of the factor , classification of content. Then our focus should be to fine tune IPAR value. Alone. These two factors will certainly boost the **α** values to more than 5%. Nevertheless, to say more iterations of **α** value will place the maximum possible advertisements in highly relevant webpage. We can simulate following graphs for our proposed-mechanism:

Table- II: Iterative values of α,β,δ,ω

Sl.No	Webpage with effectiveness value			α	β	δ	ω	Iteration
1.	$WAdv_1$	$WAdv_2$	$WAdv_3$	1.99	1.99	1.99	1.99	1
2.	$WAdv_1$	$WAdv_2$	$WAdv_3$	1.76	1.78	1.80	1.82	2
3.	$WAdv_1$	$WAdv_2$	$WAdv_3$	1.34	1.41	1.52	1.67	3
4.	$WAdv_1$	$WAdv_2$	$WAdv_3$	0.69	1.07	1.16	1.22	4
5.	$WAdv_1$	$WAdv_2$	$WAdv_3$	0.34	0.58	0.79	0.92	5

We simulated following graphs for our algorithmic proposal

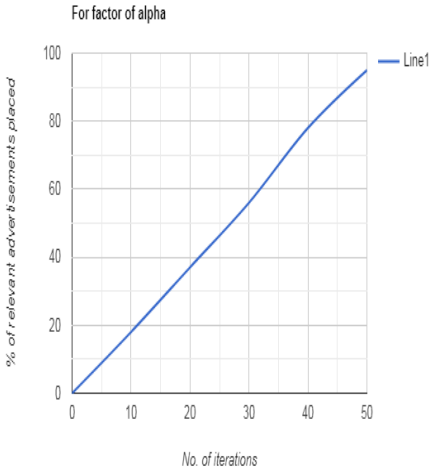

Fig.1.Performance of Alpha

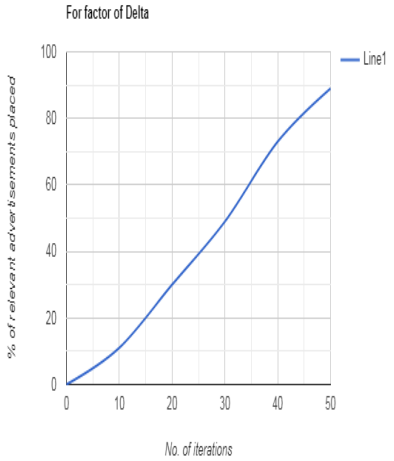

Fig.2.Performance of Delta

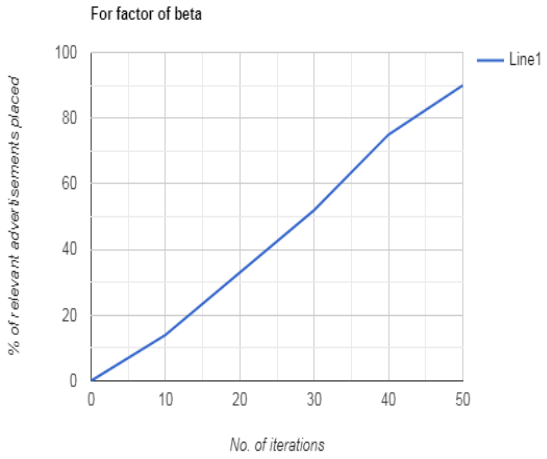

Fig.3.Performance of Beta

IV. CONCLUSION

For maximum out reach of advertisements of a specific category the challenge is to identify favourable websites. Our proposed technique helps in facing this challenges. The next challenge lies in optimal placement of the advertisement in single domain. Our grey-wolf optimiser gives better solution for this specific challenge. Our paper will serve as a base to develop robust frameworks deploying the proposed mechanism, so as to save substantial amount of time. Our proposed algorithm can help advertising companies a way to expand their marketing scope by identifying more and more websites to assign advertisements. Once this advertisements are placed , the organisations can observe the user visits thereby fine tuning factors used in our algorithm and after sometime, may be hours or days can actually, reassign the advertisements thereby gaining optimality. Our paper will act as a readymade guide for researchers in this area of optimization of advertisements placements.

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Mr. Manas Kumar Yogi pursued Bachelor of Technology from VR Siddhartha Engineering College,Vijayawada,A.P. in 2006 and Master of Technology From Malla Reddy College of Engineering And Technology in year 2012. He is currently working as Assistant Professor in Department of Computer Science Engineering , Pragati Engineering College (Autonomous), Surampalem, East Godavari District, since 2014. He is a member of IEEE & ACM since 2014. He has published more than 85 review,research papers in reputed international journals ,conferences including IETE sponsered conferences. His main research work focuses on Software Engineering, Distributed Computing, Cloud Security and Privacy, Big Data Analytics, , IoT and Computational Intelligence based optimisations. He has 10 years of teaching experience and 2 years of software industry Experience.

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