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Research paper

Identification of suitable websites for digital marketing – an approach using bio-inspired computing

B. Suresh Kumar [1] *, Deepshikha Bharghava [1], Arpan Kumar Kar [2], Ms. Chinwe Peace Igiri [1]

[1] Amity University, Jaipur, Rajasthan, India
[2] DMS, Indian Institute of Technology, Delhi, India
**Corresponding author E-mail: mtech.sureshkumar@gmail.com*

Abstract

Due to the immense growth of Internet usage, the point of convergence has moved from physical to the web. The size of the web is increasing at a very fast pace to cater to the fast-evolving needs of the businesses, governments, and societies. However, selecting or identifying the best website is challenging. The practical issue to solve the problem comprises two parts. The first part is to identify the assessment criteria for appraising websites. Second is to evaluate the websites in the context of these assessment criteria and screen them to address a specific need. However, this objective is extremely complex and computationally extremely expensive. This research proposes an approach to identify websites from the Internet. The proposed integrated approach uses the Henry Garrett ranking method and cuckoo search algorithm for ranking and selection of websites for planning digital marketing campaigns.

Keywords: *Metaheuristics; Henry Garrett Ranking; Cuckoo Search; Analytics; Machine Learning; Internet Applications.*

1. Introduction

The increasing usage of the Internet is increasing very rapidly causes has shifted the point of convergence to the web. Nonetheless, the capacity of the web is increasing rapidly. As of November 2, 2016, World Wide Web size gauging 8.76 billion connections in the huge growth of websites connecting with each other [1]. Since websitesare the most widely used outlet by companies to showcase and update their products,the present challenge is to determine and utilizethe best websites for thepromotion of their products. E-commerce sites such as Flipkart, Amazon, eBay, etc. have enhanced the safety features of their goods and services. Nowadays, the home pages of companies provide many sub-links for the convenience of customers [2-3] and price comparison for customersof products. However, it should be noted that some ofthe information on suchwebsites might be incorrect. The authenticity of the information being shared over various websites may be misleading and may affect the opinions of customers [4-5].
Recently, digital marketing has gained much attention, but the provision of information is a laborious task. It involves factors such as website content, number of links, which make it difficult to define the best website for customers in the related domain [1].
However, attempts have been made to solve these issues. The first step in resolving this issue is to analyze the censorious elements for appraising websites. The second step is to estimate the websites and screen them from the rest. This study aimed to proposes a determinant system to elect relevant websites for a specific domain in worldwide. We used the Henry Garrett ranking method (HGRM) [2] for ranking the websites, and the cuckoo searches algorithm (CSA) for optimization purpose[3]. A total of 1680 websites of different domains and 8 different ranking agencies were considered in the analysis. The results were then compared with other bio-inspired algorithms like bat algorithm (BA)[4] and firefly algorithm (FA) .

2. Review of literature

2.1. The growing importance of digital marketing

Digital Marketing encompasses a wide range of websites, blogs, discussion boards, chat rooms, and social networking websites. Owing to the wide use of the internet, developers strive to ensure that there is a high inflow of customers to e-commerce sites using new approachessuch ascustomization quality, quantity, and integrity, resulting in proliferation of websites [6].In other words, internet marketing is the process of maintaining a relationship with customers [7].
The world of web 2.0 and the huge influx of information make it infeasible to focus on all channels since both business needs, and channel receptivity depend on it [8]. Literature revealed a strong correlation between the type of information, complexity, and success of the task to be completed [8]. Further, there may be a difference the perceived importance of channels of information and the subsequent trust on that information based on the nature of information and who propagates it [9].
Organizations have started their business promotions by using social media like Facebook, Twitter, and YouTube and concepts like pay-per-view and pay-per-click [10].
Studies have also investigated business needs to understand the factors that attract people to their websites, enable them to browse through the site for a longer period, and customer retention. Business needs also help to understand the difference between a casual buyer and a user who regularly visits their websites [11].

2.2. Implications of digital marketing

The present situation of marketing applications is unproductive and lacks the potential to meet the requirement criteria of the cus-

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tomer. However, this could be resolved through digital marketing [12-13]. There is a huge gap between expected service and perceived service that may be filled using an improved service quality model and by determining how the quality of service has been influenced [14]. Digital marketing can be improved only with increasing virtual communication over the social media [15-16].

2.3. Implications of bio-inspired computing

In 2009, Yang and Deb [17-18] proposed CSA, which wasbased on nature-inspired metaheuristics, i.e., brood parasitism of some species, for optimization. The CSA is strengthened by levy flight rather than isotropic walk and can be utilized to design engineering applications. This algorithm also has an admirable performance compared to other optimization algorithms like FA, ant colony optimization, and artificial bee colony.
The CSA has adopted in escalation fields and computation intelligence among auspicious productivity. In engineering design applications, CSA has admirable achievement over other algorithms for continued upsurge complications such as spring design and welding problems [19]. In 2011, Amir Hossein Gandomi and Xin-She Yang [20] recently developed meta heuristic optimization algorithm using the social behavior and flashing characteristics of the fireflies for solving mixed continuous/discrete structural optimization problems. Their study explained how the optimization progresses can be gradually reduced using the overall behavior of the FA. In 2011, J. Senthilnath, S.N. Omkar and V. Mani [21] implemented the clustering approach with the FA for solving major benchmark problems [22] and evaluated the extracted knowledge with classification error percentage and classification efficiency. In 2010, X.S. Yang [23] proposed a new metaheuristic algorithm named BA, which was based on the echolocation behavior of bats, to solve continuous constrained optimization problems. In 2013, Iztok Fister Jr., Du San Fister and Xin-She Yang [21] proposed a new swarm intelligence algorithm. A Hybrid BA which is hybridized with differential evolution strategies to solve the Promising complex optimization problems [24].

3. Scope of study and motivation of research

Many studies have investigated the use of digital marketing for promoting businesses and have proposed and introduced lots of various techniques for business promotion. Nevertheless, none of these studies have focused on how to select or identify a suitable website for digital marketing. Therefore, the major challenge of this proposed work is to provide valid content to the customers. Some of the key issues are as follows: 1. Fake advertisements [25] on websites that misleading the customers; 2. Data collection from the users or customers for better improvement; 3. Software used to meet the current technology; and 4. Selecting the location-based patterns. Traditional website recommendation mechanism is content-based or uses a collaborative approach. However, it fails to analyze the quantitative and qualitative relationships between the customer and the owner, which may lead to customers' online decisions [23]. To optimize all these issues, this study attempts to estimate the perceptions of users that can help to identify the best websites for digital marketing. This work also concentrates on qualitative and quantitative approaches by collecting data from reputed agencies like Alexa, DMOZ, etc. Furthermore, the study concentrates on perceptions of users in the selecting suitable website and features the estimates of different categories. The aim of this study is to identify suitable websites for digital marketing for single or multiple domains.
This study considers different ranking agencies to rank websites based on certain parameters like website age, Domain Authority, page links, etc. This research emphasizes on identifying a set of parameters helpful in tracing the suitable website. The retrieved results were mapped and categorized into seven traits. This study also creates a mechanism to identify the best website, as well as the relevant websites, using nature-inspired algorithms.

4. Research methodology

An amalgamated research methodology had to be followed in this study because a single associative approach may make itdifficult to produce the research objectives. This study endorses different domains such as digital marketing, e-commerce techniques, and Bio-inspired computing [26]. The ranking data were collected from different ranking agencies like Alexa, DMOZ, PageRank, etc.[27].
A total of 1680 websites and 8 parameters were identified for this study. The sample data arelisted in Table 1.

Table 1: Showing the Sample Data Set

S. No.	Name of the website	Moz-DA	Alexa	PR	MozPA	Do-mainAge	Face-book	Google	Twit-ter
1	www.Facebook.com	100	3	9	97.08	20years 4months	0	5	6
2	www.Twittter.com	55.41	6	0	61.89	17 years 6 months	9	4	0
3	www.linkedin.com	54.80	8	0	60.03	7 years 3 months	6	8	7

The literature focuses on the denotation of factors like

- Websitecontent
- Construction
- Playfulness
- Serenity ofuse
- Definiteness
- Responsiveness
- Graspedsuitability
- Interdependentassociation

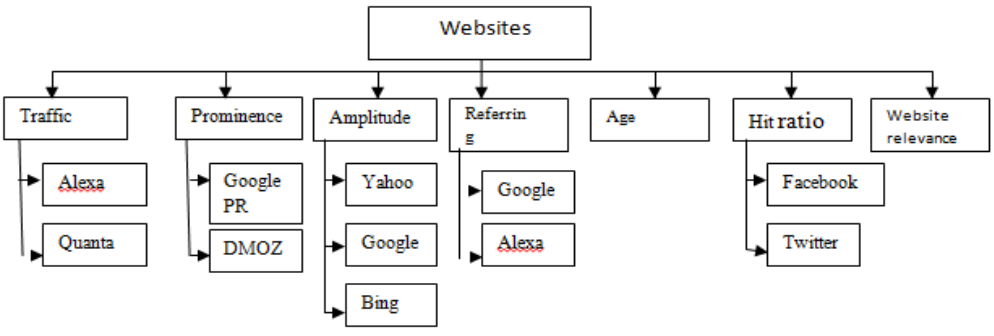

Fig. 1: Parameters Mapped to the Website.

After finding the factors, we further analyzed them using the two sample T-test assuming unequal variances[28] for identifying the significance of parameter's significance. The t-value is considered only when the mean value of the parameters ispositive. Then we extracted the corresponding P-value of parameters. This analysis considered the P-value greater than 0.05 as insignificant. Table 2 shows the P-values of correspondingparameters.

Table 2: P-Values of Significant Parameters Using T-Test

Parameter No.	Significant Attributes	P-value
P1	Index	3.2285E-242
P2	MozDA	4.4113E-170
P3	Alexa	1.5559E-250
P4	Page Rank	2.22785E-05
P5	MozPA	0.093961637
P6	Facebook	1.2735E-250
P7	Google	0.132163328
P8	Twitter	1.2795E-250

On the other hand, it is not possible to check out the factors for a single website with multiple agencies. Thus, there are many criteria for grading. Some of the criteria are

1) Traffic ranking Alexa ranking, Quantraking
2) Prominence rank: Google page rank, DMOZrank
3) Amplitude of significance: Yahoo, Google,bing
4) Number of referring domains: Google back links, Alexa backlinks
5) Ageranking
6) Websiterelevance
7) Hit ratio: Facebook, Google PageRank

In this study, the critical criteria were calculated for a specific evaluation using HGRM. The Henry Garrett function wasused to rank the set of variables in statisticalanalysis.

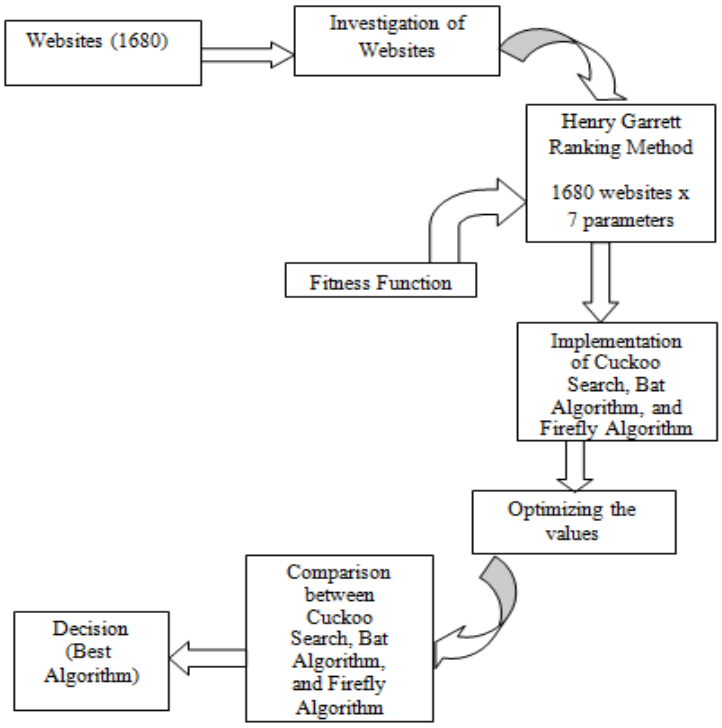

Fig. 2: Process Diagram.

Consequently, for identifying which parameters may become relevant for our study, aranking strategy, i.e., HGRM, was applied. As per this method, the respondents were asked to rank all the strategy's outcomesthat were converted to score value[14]. The rank scores varied from 1 to 100 depending on the values given by the respondents. After scaling the entire parameters, we applied the Henry Garrett function on the values[14].

The process was repeated for all parameters until all attributes were normalized. Later, we concluded the priority of parameters using Henry Garrett table values. A ten-point scale was usedfor prioritization of the attributes[14].

4.1. Data description

The website's data collected for the purpose of this study werehighly enriched and consisted of parameters such as website content, serenity of use, construction, grasped suitability, playfulness, interdependent association, definiteness, seclusion, and responsiveness

Numerous values were also given by Alexa ranking agency, website age, Dmoz ranking, PageAuthority, etc., Thus,the analysis ofthis meta-data revealed the importance of the website. We have also considered 7 metrics as described herebelow:

Table 3: Description of 7 Metrics

S.no	Metric Name	Description
1	Traffic Ranking	A site's ranking is based on a combined measure of unique visitors and page views
2.	Prominence rank	Ranking is based on back links.
3.	Amplitude of significance	It is based on ranking functions, semantic matching features, and query rewriting.
4.	Numberof referring domains	A referring domain is the domain from which theback links are coming. Back link: A back link is a link on another website that points to your site.
5.	Age ranking	This ranking describes how old is thewebsite.
6.	Website relevance	Relevancy ranking is the process of sorting the document results so that those documents which are most likely to be relevantbased on their relevancy to your query.
7.	Hit Ratio	This ranking is based on hits.

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5. Proposed solution

As discussed in the previous section, the data considered for analysis encompasses 7different metrics and the range of value of each metric varies greatly. Thus, this poses a challenge for normalization.

5.1. Determinant approach for guesstimate and election

This study uses two methodologies for the determination of suitable website for promotional activities. For the first part, it uses HGRM for computing the evaluation criteria. In the second phase, it uses CSA for evaluating the performance of websites against the criteria.

5.2. Henry Garrett ranking method (HGRM)

The HGRM was developed for ranking multi-dimensional and multi-criteria problems. Initially, the entire data set is prioritized based on their ranks provided. The ranking of this method ranges from 1 to 10, which is equivalent to best to worst, respectively. A sample of 100 websites was selected randomly from different agencies like DMOZ, Alexa, etc.; these 100 websites were from the meta-category business thathad 1,102,175,281 listed website's information gathered from Google survey.These websites were then ranked on 10-point scale according to cluster or range of data to each factor, i.e., each ranking agencies. In the research, we have taken 9-factor values for a single website. They are as follows:

1) Index
2) MOZDA
3) Alexa
4) PageRank
5) MOZPA
6) Facebook
7) Googleplus
8) Twitter
9) Websiteage

5.3. Objective function

$$F(x) = \min(\sigma Xi) \quad (1)$$

Where x_i = 1 to n (No. of websites)
The above objective function calculates the best websites according to the parameters with the following algorithm:

Algorithm:

1. Set the nest size n, where $1 \leq xi \leq n$
2. Probability ratio $Pa \in$ Error! Bookmark not defined. and Maximum number
3. of iterations Max $_i$
4. $\text{SettheParameters}^{rj}$ where $1 \leq rj \leq m$

Set i=1 { counter initialization}

5. For {i=1:i≤n)do
   i. Generate a new solution (Cuckoo) $X_i$randomly
   ii. Evaluate the objective function of a solution X_i,$f(X_i)$
   iii. Choose a nest X_j among n solutionsrandomly
   iv. If ($f(X_i)>f(X_j)$then

Replace the solution X_j with the solution X_i+1 End if

6. Abandon a fraction P_a of worstnests.

Build a new nest at new locations, a fraction P_a of worse nests

7. Carry the finestsolutions

Rank the solution and find the current best solution

8. Set i=i+1.{ iteration counter increasing}Until ($i<Max_n$){Termination criteria asatisfied}

Fig. 3: Modified Cuckoo Search Algorithm (MCS).

After abundant computations by so many researchers, it has proved that CSA is always found flawless exploration relies absolutely on incidental pace, a fast merging cannot be possible. In our algorithm, the major changes according to the original algorithm are targeting the convergence rate. For these modifications our CSA more constructive for a wide range of applications.

6. Implementation

A comparative summary of the three bio-inspired optimization approaches was prepared. These algorithms are FA, which is inspired by the behavior and movement of fireflies; BA, which is based on echolocation behavior of bats; and CSA, which is based on the behavior of cuckoos for hatching ofeggs.

6.1. Firefly algorithm (FA)

This is a biologically inspired metaheuristic approach that simulates the flash pattern and characteristics of fireflies. It is usually governed by three main rules as follows: [6], [29-30]

i). All fireflies are unisex and can attract eachother.
ii). Fireflies glow brighter to attract others and for sharing thefood.
iii). Attractiveness of fireflies is directly proportional to the brightness; less bright fireflies move towards the brighterones.

Algorithm: Begin
Generate initial population for fireflies, x_i, i=1…n
Light intensity L_i associated with each X_i determined by f(X)
Objective function: = f(X)
Initialize light absorption coefficient γ For all fireflies in the population, If($L_i<L_j$)
Move i firefly towards j;
Attractiveness (β) can be varied by
Where β is the attractiveness at distance d. Rank fireflies and find current best solution End
Parameter values
∝ (Randomness): 0.2 Γ (Absorption Coefficient):1.0 β=0
Population: 1680
Advantages:

1) The social aspect of fireflies provides an efficient means of traversing a search space.
2) Avoiding any localoptima.
3) Randomness reduction and scaling of thedistance.

Disadvantages:

1) Localoptima
2) Randomnessreduction.

6.2. Cuckoo search algorithm

The CSA is a population-based global search algorithm for solving structural optimization tasks. It considers the below three idealized rules:

i). The cuckoo birds lay their eggs in the nest of other host-birds.
ii). Female cuckoo can imitate the colors and patterns of a few host species increasing reproductively as eggs do notget abandoned anddestroyed.
iii). Each egg in the nest represents a solution while cuckoo eggs are the new solution. Here, the aim is to employ new and potentially bettersolutions.

Algorithm:
Begin
Generate initial population of 'n' host nest, X_i, i=1….n
Get a cuckoo i randomly by Levy flights L
Select a nest j among nests n
Fitness of cuckoo i: Fi
If (F_i>F_i)
Replace j by new solution
Abandon fraction of nests and build more solution x_i at time v is the new solution by
Levy L.
Where
s>0(Step size)
Keep the best solution
Rank the nests and find the current best solution.
End
Parameter values Discovery Rate: 0.25 Tolerance: 1.0e-5 Levy; 3/2 Population: 1680
Advantages:
The CSA exposes the global convergence abilities with the following features:

1) It satisfies global convergencerequirements.
2) It supports local and global searchcapabilities.
3) It uses Levy flights as a globalstrategy.

Disadvantages:

1) Large-scale globaloptimization.
2) Systematical and theoreticalanalysis.
3) Parameter tuning andcontrol.

6.3. Bat Algorithm (BA)

It is a based on the echolocation behavior of bats that possess varying pulses ratesof emission and loudness.It considers the below three idealizedrules:[4]

i). Bats use echolocation for sensing distance and can differentiate between background barriers and theprey.
ii). While flying they can adjust their wavelength and pulse emissions.
iii). (iii)Loudness varies from a minimum to maximumrange.

Algorithm:
Begin
End
Generate initial population X_i and velocity v_i. Pulse frequency f_i at X_i
F_i
Define Pulse Rate (R) Where
Loudness
Accept new solution, reduce loudness and increase pulse rate. Rank bats and find current best solution.
Parameter Values:
Loudness: 0.5
Pulse Rate: 0.5
Population: 1680
Advantages:
The analysis of the key features of BA is based on the following;

1) Frequencytuning.
2) AutomaticZooming.
3) Parametercontrol.

Disadvantages:

1) Parametertuning.
2) Parametercontrol.
3) Speedup ofconvergence.

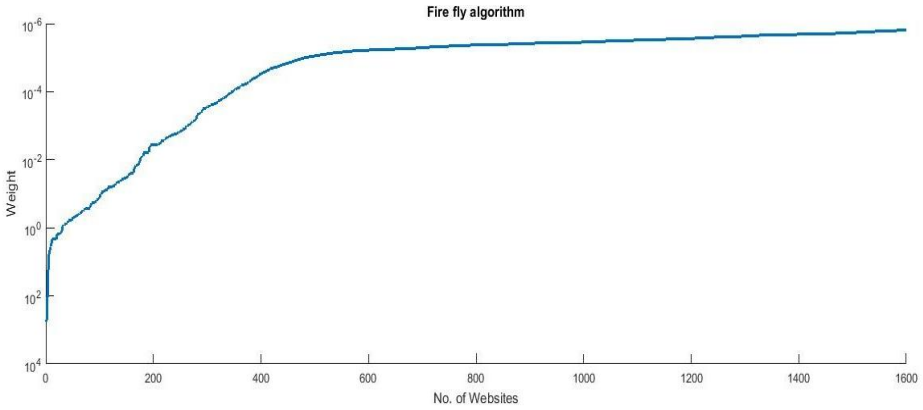

Fig. 3: Result Analysis (Firefly Algorithm).

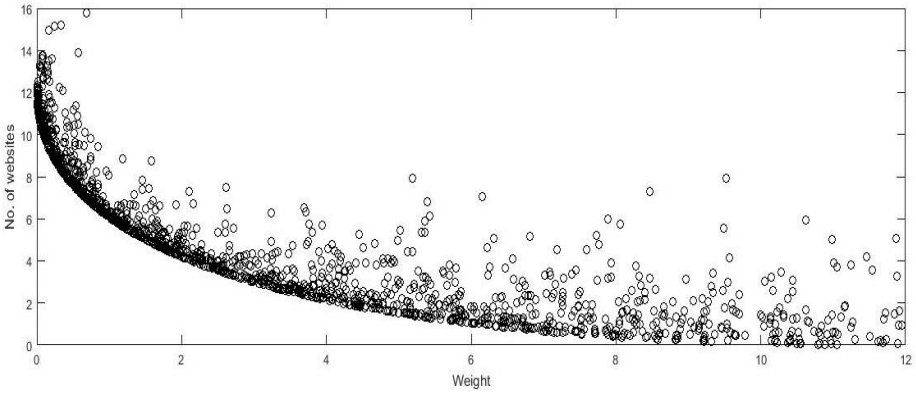

Fig. 4: Result Analysis (Bat Algorithm).

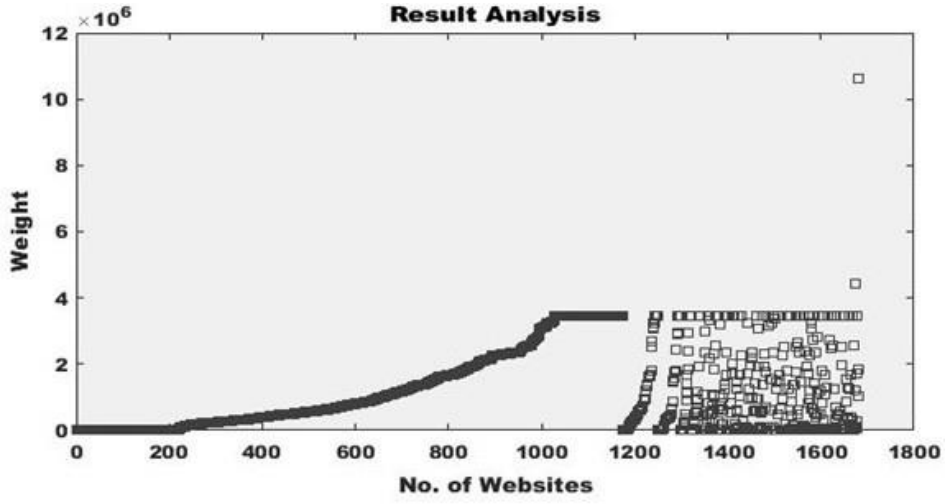

Fig. 5: Result Analysis (Modified Cuckoo Search (MCS)).

7. Performance evaluation

Table 4 shows the results of the three approaches of FA, BA and CSA.

Table 4: Information about Best (B) and Worst (W) Websites

Algorithm	Best	Worst
Firefly	106.10978	1.3762
Bat Algorithm	106.10972	1.3750
Cuckoo search	106.10983	1.3750

As discussed within the data description section, we have considered seven parameters for analysis of websites. To verify the similarity in parameters, we used the ranking strategy. In this research, we have used HGRM for objective function. In this method, we did the 1 to 100 scaling of available data for normalizing instead of a minimum-max method. However, The HGRM approach is not sufficient to find the best value; thus, bio-inspired optimization algorithms, i.e., CSA was employed. The integrated approach is referred to as optimization and successfully calculates the current best solutions. Reviews of bio-inspired algorithms highlight a wide range of algorithm's that may be used for analysis and optimization [17]. The algorithms used throughout this analysis includeCSA [31-32], BAand FAoptimization techniques integrated with HGRM.

The HGRM approach can be divided into the following steps: 1. Initialization, 2. Clustering for ranks, 3. Estimation Percent position, 4. Updated with the Henry Garrett values, and 5. Finally, evaluation (or) exploration.

The HGRM approach is a simple method for ranking strategies but has the drawback of falling into local optima. This problem may be avoided with the help of bio-inspired algorithms. In this study, we have integrated both these approaches for optimization. This process repeats until the best nest is found. After calculating the optimized values with CSA, we have compared the results with BAand FA. The above three algorithms were implemented through MATLAB. The results for three integrated approaches vary in terms of accuracy with minimal variations. The HGRM integrated with CSA showed good resultsin comparison to the other two algorithms.

The CSA is a non- swarm intelligence for finding global optima in meta heuristics. It overcomes the drawback to the HGRM approach. The CSA will search the best nest within the available nests.

8. Conclusion and futures cope

The study discusses suitable application parameters for identifying the best websites. An analysis has been done for various websites. The current literature on digital marketing does not explore how to identify the best websites. The significant indicators are Index, MOZDA, Alexa, Page Rank, MOZ PA, Face book, Google plus, Twitter and Website age. The metrics have also been used as a proxy measure for the seven parameters namely traffic ranking, Prominence rank, Amplitude of significance, Number of referring domains, Age ranking, Website relevance and Hit ratio. This study has analyzed the total number of 1680 websitesfromdifferentcategoriestoidentifythebestcaseaswellastheworstcase.

For analysis purpose, we have used Henry Garrett ranking strategy with CSA, BA, and FA. Out of three approaches, the integrated CSA gives the best result out of the three algorithms. However, future studies should consider the ranking method to prepare clusters and optimization with soft data sets and for evaluation criteria. This study also contributes to the identification of the best website. One of the limitations of this study is that it does not discuss the swarm intelligence method for the existing data. In future, the

study can be extended for understanding and implementing both swarm-based and non-swarm algorithms for longer data sets. This study could also be extended to include data mining algorithms for classification and decision-making systems. However, despite these minor limitations, the findings from this study have strong relevance in domains like digital, marketing, electronic and mobile commerce.

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