

Insights into Search Engine Optimization using Natural Language Processing and Machine Learning

Vinutha M S¹, M C Padma²

Research Scholar, Department of Computer Science & Engineering, P E T Research Centre, Mandya,
University of Mysore, Mysuru, India¹

Professor, Department of Computer Science & Engineering, PESCE, Mandya, India²

Abstract—Among the potential tools in digital marketing, Search Engine Optimization (SEO) facilitates the use of appropriate data by providing appropriate results according to the search priority of the user. Various research-based approaches have been developed to improve the optimization performance of search engines over the past decade; however, it is still unclear what the strengths and weaknesses of these methods are. As a result of the increased proliferation of Machine Learning (ML) and Natural Language Processing (NLP) in complex content management, there is potential to achieve successful SEO results. Therefore, the purpose of this paper is to contribute towards performing an exhaustive study on the respective NLP and ML methodologies to explore their strengths and weaknesses. Additionally, the paper highlights distinct learning outcomes and a specific research gap intended to assist future research work with a guideline necessary for optimizing search engine performance.

Keywords—Search engine optimization; google search; natural language processing; machine learning; recommendation

I. INTRODUCTION

In the present era of the competitive market, every organization and individual intends to ensure that their information reaches the right clients in minimal effort. Stakeholders also need to have a clear insight into their upcoming business demands. From all these perspectives, business products and services are usually maintained via websites. This target is met by using Search Engine Optimization (SEO), which facilitates carrying out the operation to assist the client webpage or its contents to offer higher ranks on the standard platform of Google [1]. The prime distinction between paid advertisement and SEO is that SEO uses an organic methodology to generate ranking scores [2][3]. It will eventually mean that a user will not be required to pay to be in that environment of using SEO [4]. In simplified form, the user of SEO tools identifies and extracts suitable content from a target webpage and optimizes it so that the webpage always appears at the top of google searches [5]. SEO tools, therefore, assist in making higher visibility of the webpage and offers a higher probability of reaching the maximum number of customers. There standard operational taxonomy of SEO is of two types, i.e., on-page and off-page process SEO [6][7]. Basically, the ranking associated with the webpage can be improved by appropriately building the web content using an on-page process of SEO. This process essentially includes constructing higher-quality content, generating appropriate keywords, managing meta-tags, and enhancing the different

objects to ensure that it is well-chosen by the target customer in the on-page SEO process. On the other hand, the backlinks' optimization process is carried out at the backend of the webpage in the off-page process of SEO. This form of SEO mainly focuses on establishing relationships among the content to reach its appropriate customer. Currently, a specific set of programs called bots are used to perform crawling within the webpage using existing search engines, viz. Bing/Google [8]. This operation aggregates information associated with the target web contents, placing them in the form of an index. The web contents are analyzed within the index by such algorithms considering a massive number of signals or ranking values. This is done to ensure the availability of the page at the top of query hits. The prime target of such a form of the search algorithm is to evolve up with a highly authoritative page to offer a superior experience of searching by the user. Irrespective of all the efforts towards improving the performance of SEO tools, there are still serious concerns that have posed as an impediment, viz. i) inaccurate formulation of webpage index, ii) identifying and constructing a precise keyword, iii) structuring the wrong webpage/contents not in line with the target topic, iv) internal linking to be highly incoherent, v) slower /fluctuating uploading performance of the web page in different computing device [9][10]. Therefore, this paper identifies the potential of using Natural Language Processing (NLP) and Machine Learning (ML) approaches to improve the performance of SEO. The paper contributes to potential learning outcomes from existing literature. Further, it also contributes towards identifying significant research gaps extracted from existing techniques to improve SEO performance.

The paper's organization is as follows: Section II discusses the fundamental information about SEO, followed by reviewing existing research practices of SEO with NLP in Section III. Section IV discusses ML practices used in SEO while Section V discusses existing SEO tools. A discussion of existing research trends of SEO is carried out in Section VI, while the research gap is highlighted in Section VII. Section VIII makes discussion about the results and research implications. Section IX finally concludes the paper with significant learning outcomes followed by a briefing of future work to be carried out.

II. INSIGHTS ON SEO

This section presents insights into SEO or Website positioning. Firstly, a brief description of SEO followed by a

working principle of a search engine is discussed to understand the intrinsic mechanism of SEO. Further, factors affecting website posting are briefly discussed, and finally, this section discusses challenges in SEO.

A. Search Engine Optimization

SEO is an act that includes a series of professional activities. These activities include the practice of improving the structure of content, thereby increasing visibility in search engines and gaining a large amount of traffic to the website [11]. Common SEO practices include rich content creation, keyword optimization, and link building. Thus, SEO is a powerful mechanism for advancing search engine algorithms to come up with the most relevant and appropriate web content and improve the website's ranking (in an organic way) in search results, ultimately boosting marketability and increasing sales.

B. Work Principle of the Search Engine

Search engines are obviously fundamental to the SEO process, but many practitioners are unaware of how they work. Therefore, one must first comprehend the basics of search engines to learn SEO. A search engine is a service that enables web search by performing three important tasks such as crawling, indexing, ranking, and recognizing items in the system record or database corresponding to keywords specified by the user [12-13]. Crawling enables search engines to discover content, and indexing is a mechanism for obtaining web documents and maintaining replicas of the content they have visited. The ranking is mainly subject to search engines mainly concerned with SEO operations. Fig. 1 depicts the schematic architecture of the web content indexing process.

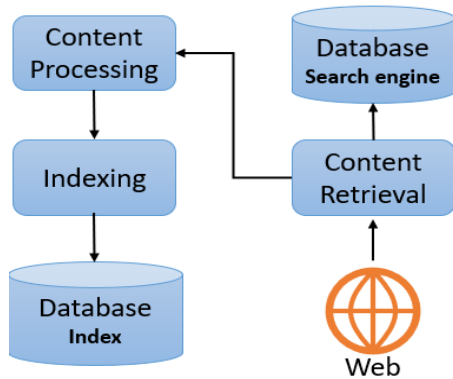


Fig. 1. Procedure of web content indexing

Web content is retrieved using a WebCrawler (bot) that stores the web content in a database of search engines. In addition, web content is subject to data processing operations such as stemming, HTML tag, and stop-word removal. Later, indexing is done by search engines by generating direct and replicating content, such as single words and their positional information on the search page. Furthermore, the search engine keeps the indexes in its index database. Fig. 2, depicts the schematic architecture of the content querying and retrieval procedure.

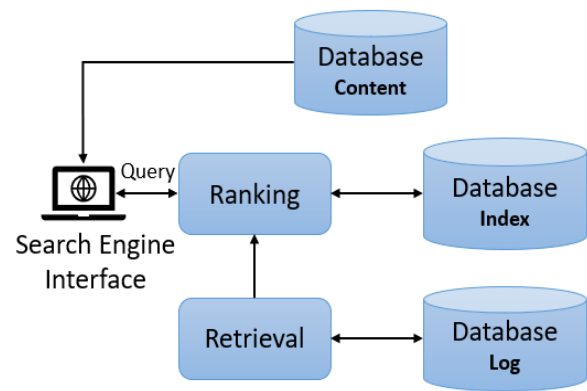


Fig. 2. Content querying and retrieval

Through the search engine interface, the user provides a search query. The search engine algorithm creates a URL ranking list that matches the user's query to the index database based on contextual information. The search engine then displays a snippet subjected to the ranked URL to the user, who can browse and select to retrieve the corresponding content in its original form from the content database.

C. Factors Affecting Ranking and SEO Challenges

The ranking of web content is influenced by many factors, including page relevance, temporal factors, and link weights [14]. A webpage's relevance is determined by its tags, density distribution, and identical keywords. Temporal aspects are concerned with the oldness of websites, web contents and webpages, the oldness of links, and the duration of domain registration. There are both internal and external links in the contents. However, the external link is given more weight as it is associated with significant factors such as quality, quantity, relevancy, and repetition. A basic mechanism of SEO includes almost all the core attributes of the above-discussed factors, which can be numerically simplified and expressed as follows:

$$Seo = \int C + L + K + O \quad (1)$$

Where, C is the web content, L denotes link, K refers to user keyword, O represents other factors such as oldness of website, or blog, server, web-design, URL, domain name, and many more. All these factors have priority and should follow priority order as mentioned in the above expression 1. Apart from this, a few challenges associated with search engines significantly affect the quality of the SEO process [15-16]. The first major issue is content spamming, a common method used by unethical users to get their web pages in top results. The next issue is the article spinning, similar to scraping data using specialized software that takes the copied original and reproduces it as a new, original article for future use. The third issue is keyword stuffing, in which users reuse keywords like name, meta, head, etc., in different HTML tags and URL spammers. Furthermore, masquerading is an SEO technique used to mislead users by redirecting them to a page that is different from the page crawled by search engines. Similarly, a URL redirection is also a significant issue where the file is redirected to a specific URL as soon as the user loads the site.

III. REVIEW OF SEO APPROACHES USING NLP

NLP is an area of ML that reveals the precise structure and meaning of content. Modern websites are driven by algorithms, which determine what they display in search results for specific keywords. Using NLP in optimizing web content, it can be expected that the content would reach the top of the search rankings. NLP can be used to analyze website content and optimize it for specific keywords or phrases. It can be used to identify and correct grammar and spelling errors, as well as to generate content that is optimized for search engines. NLP techniques can also be used to analyze user queries and optimize website content to better match those queries

Many research works are using the mechanism of NLP to achieve optimization in the search ranking. This section provides a brief highlight of the existing literature in the context of SEO. A research article presented by Killoran et al. [17] has examined the influential factors that have a high impact on search ranking. It is reported that search ranking is formed on the basis of participants' category, SEO experts, search engine companies, and users. During the choice of keywords, the authors stated that the website's target audience and competitors have to be taken into account. The study concludes that a combination of appropriate keyword placement and link-building may yield the desired solution. The study of Hajeer et al. [18], applied the NLP mechanism to overcome the limitations associated with the Porter algorithm used for term normalization and index time reduction in the content retrieval systems. The authors have presented a different stemming technique to enhance content searching in an information retrieval system. The results claim improvement over existing technologies. Tsuei et al. [19] devised a customized decision model based on the interview and survey for SEO in internet marketing to boost the hit rate of websites on the search page that satisfy users' requirements. The finding of this study suggests that meta tags are the most influential factor that has a significant impact on the search ranking.

The work of Luh et al. [20] aimed to examine the ranking mechanism of the Google search engines from an SEO viewpoint. The study suggested an estimation function for determining the score of query matching from a limited set of ranking factors. Further, re-ranking is carried out on the basis of obtained scores. The scope of the presented scheme is evaluated based on the comparison of newly obtained ranks with the original ranks. Jenkins et al. [21] developed a model for constructing text annotations for SEO. This model employs the Extreme Gradient Boosting algorithm for precise labeling phrases. Also, logistic regression is considered in this model to generalize the rank of aggregated annotations for clusters of content. The study findings demonstrate that the presented model increases the traffic to the web content by 1-2%. A semantic architecture using web and data mining techniques is presented by Sharma et al. [22] for personalizing the eCommerce search engine. The design and development of the architecture consist of a series of implementation phases were, firstly, a query expansion is performed to transform the input user query using NLP operations to understand the user

requirement. Afterward, ontology classification is carried out to filter out the relevant subjects of the web content. Further topic modeling is carried out using clustering, and statistical computation is then carried to perform a re-ranking operation. Semantic annotation for semi-structured data on a web page using header identification and object classification is presented by Zhang et al. [23]. The authors have designed a description framework for annotating the data domain, and header identification is carried for annotating data objects on the webpage. In addition, a feature vector is constructed for data objects which are left by header identification, and a neural network is then applied to perform semantic annotation.

Adoption of the latent semantic analysis for SEO is carried out by Horasan [24]. In this study, the keyword extraction process from textual data with latent semantic analysis is performed to draw a relationship between documents/sentences and terms in the text using linear algebra. Uzun [25] suggested a model-based string technique and DOM tree for content extraction. The string technique extracts information with the HTML tags followed by the crawling process. The study of Barrett et al. [26] presented an approach for searching large video corpora for clips depicting human language queries expressed as sentences. In this study, a compositional semantics scheme is applied to encode refined meaning to extract the differences between two phrases with the same words under a different context. Sal et al. [27] used a disseminated cooperative cache based on evolutive summary counters to store approximate records of data accesses in a search engine. Ghanbarpour and Naderi [28] examined the ranking technique for keyword search according to the relevancy of the query over graph-structured data. Soltani et al. [29] employed an approach of semantic search engines to develop a different model for software signature search engines. The authors have used the document-to-vector model to compute the signature and user query vectors.

The work of Dai et al. [30] suggested an efficient and adaptive semantic-based keyword ranked search technique using Doc2Vec for secured cloud data. Chen [31] focuses on adopting a user interaction approach to control linguistic ambiguity to improve search engine outcomes. Zhang et al. [32] have suggested a scheme to recognize the identifiers that are associated with semantic text queries. In order to enhance text queries, the authors have looked for keywords within class names from APIs with semantically related APIs. However, if the corpus projects do not have sufficient vocabulary, this technique may not work as well. Calvillo et al. [33] presented an automated mechanism to classify and locate research information based on NLP. The implementation of this scheme focuses on cleaning data by removing aspects such as images and words that are not significant. The digital library was used to extract a percentage of the content from different articles such as abstract, introduction, keywords, and other segments of the article, which help to perform the tests. Hamzei and Hakimpour [34] introduced a method for analyzing queries for spatial search engines. This method employs iterative query segmentation identification of location-names and spatial relationships. Table I highlights the summary of the work being discussed in this section.

TABLE I. SUMMARY OF SEO USING NLP TECHNIQUES

Authors	Problems	Techniques	Advantage	Limitation
Killoran et al. [17]	Search ranking	Analytical study	Highlights influential factors, and important suggestion	Only theoretical and analytical discussion
Hajeer et al. [18],	Indexing time	Stemming	Outperforms Porter algorithm	Related to Over-stemming and only 2.3% of improvement
Tsuei et al. [19]	Identification of factor affecting SEO driver	Decision making system	Highlighted significant website SEO factors	subjective opinions of decision-makers
Luh et al. [20],	Examine ranking of the Google search engines	Rank estimation function and re-ranking scheme	Achieved the best SEO effectiveness	Considered limited set of ranking factors
Jenkins et al. [21]	Understanding content to attract new user	XGBoost and Linear regression	Increases traffic by 1-2 %	Higher dependency on more keystrokes.
Sharma et al. [22]	SEO for ecommerce	Ontology and Semantic Approach	Provides context-aware results and recommendations	Lacks statistical outcome analysis to justify its usability
Zhang et al. [23]	Identification for highlights of multimedia file system	Annotation, Header recognition, Neural network	Semantic annotation of semi-structured information	Only applicable for Chinese language
Horasan [24]	Adoption of knowledge contents	Latent semantic analysis and linear algebra	Complies with the SEO criteria, helpful for who do not know SEO	No effective benchmarking
Uzun [25]	Time efficiency in Web scrapping	String technique and DOM tree	Achieves time efficiency in web scrapping	Dependency on various manual process
Barrett et al. [26]	searching large video corpora from text query	searching large video corpora	Does not require any prior video annotation	Computationally in-efficient
Sal et al. [27]	understanding the underlying content of multimedia	Cooperative cache scheme	Flexible to support large data for analysis	Domain-dependent implementation
Ghanbarpour and Naderi [28]	ranking search problem	Model-based ranking function	Improves the accuracy of the ranking	Only support single keyword search
Soltani et al. [29]	Digital security	Paragraph Vector Model	Achieves higher recall rate	Computationally expensive
Dai et al. [30]	multi-keyword ranking search	Doc2Vec model	Simplified structural model	documents may be lost in the encrypted forms
Chen [31]	misinterprets the user query	Personalized topic search system	Quick response to user search needs	Limited to English language and used small dataset
Zhang et al. [32]	Recognition of the identifiers that are associated with semantic text query	Neural network model (CBOW)	Provides a good scope	If the corpus projects do not have sufficient vocabulary, this technique may not work as well.
Calvillo et al. [33]	locating research paper	NLP based SEO	Better performance in the classification of research article	does not capture position in text,
Hakimpour [34]	analyzing queries for spatial search engines	Iterative query segmentation and spatial relationships.	Better interaction between the users and the search application	Induces to spatial complexity

IV. REVIEW OF SEO APPROACHES USING ML

The prime objective of any SEO approach is to find the targeted content which could meet the expectation of the user and thereby make the web content available to them with least effort. This operation demands a better for of optimization, where Machine Learning (ML) approach plays a significant contributory role. ML can help SEO professionals by analyzing the vast amounts of data required to optimize a website's ranking. For instance, it can be utilized to search ranking factors to get insight into website age, bounce rate, and content length. These were significant indicators of high-ranking websites. ML can also help predict future search engine

algorithm changes, enabling SEO professionals to make proactive adjustments. Overall, the use of ML in SEO offers numerous benefits, including increased accuracy in predicting search engine algorithms, automation of SEO tasks, and the ability to analyze large amounts of data. This section briefs about some of the literatures where ML approaches has contributed towards this optimization process considering various forms of use-cases.

The most recent work carried out by Boppana and Sandhya [35] have used Recurrent Neural Network (RNN) in order to facilitate a better form of recommendation system to be used in SEO operation with perspective to web crawling practices. The

core target of this work is mainly to reduce the error while recommending the popularity of extracted information. A clustering approach based on extracted features from contextual information is implemented in this process. The work carried out by Burgess et al. [36] address the problems associated with security of web-contents, which is another essential concern in SEO process. The authors have used Long Short-Term Memory (LSTM) for identifying the possible threat in traffic associated with web-content while making redirection in HTTP. The study claims of successful control of such malicious redirection. Similar aspect of security consideration was also witnessed in investigation carried out by Liu and Fu et al. [37] where an SEO tool is required to confirm the vulnerability in the web-contents. The solution is provided by the author by considering phishing attack on web contents where feature learning is used. The study has used an unsupervised learning methodology in order to identify the insecure web-contents. Further, the model has also used a random walk of biased nature considering fusion of information over URL and structural information.

Soliman et al. [38] have implemented a model using random forest for addressing the need of semantics and linked data of the web-contents. The implementation has used Resource Description Framework (RDF) where random forest is used for retrieving the current state of RDF for assisting in further classification process. Study in the direction of the recommendation system in SEO is also reported in work of Ismail et al. [39], where the focus is mainly towards customizing the recommendation system over web-contents. The study model has used fuzzy logic concept integrated with structural analysis for achieving adaptive recommendation system. Label propagation is another essential target to be achieved in SEO and it becomes quite challenging in presence of heterogenous information. Study in such problem is addressed by Hisano et al. [40] by storing a voluminous information in the form of a network followed by applying Jacobian iteration for learning weights. This technique also contributes towards performing better analysis. It should be noted that web-contents consideration in SEO will also be inclusive of presence of multi-media file systems too. It is found that identification of highlights of such files is completely dependent on trained data curated by human. This hinders scalability as well as is expensive in nature of deployment. This problem is addressed in work of Kim et al. [41] by introducing a ranking mechanism using deep learning technique in presence of noise. The technique is completely free from any category as well as harnesses such web-contents that are weakly supervised.

A unique work carried out by Lister [42] has considered a use-case of improving knowledge transfer using machine learning approach. The idea of this model is to make use of all the essential geo-spatial information associated with educational system and use them for constructing content, searching relevant contents, and exploring essential knowledge contents. This process exponentially facilitates for SEO implementation over educational system. Adoption of SEO towards education system is also investigated by Peralta et al. [43] where a problem associated with tedious search process by teacher in finding appropriate content is addressed. The study has used a probability-based computational framework followed by resource classification in the form of clusters to make the search easier. Studies towards educational system further continues in the work of Rahman and Abdullah [44] which deals with more about customization of recommendation system.

Credibility is another essential attribute to be considered during SEO operation in order to assess the source of information. Such motive is seen to be implemented in work of Mahmood et al. [45] where reputation computation is carried out by eliminating the negative referrals. The study has used feedback-based Bayesian network in order to compute the level of expertise. Further, the work of Massaro et al. [46] have used neural network along with LSTM in order to assess the influence of web-content over an experience of user. Social network plays a dominant role in its interactive web-content where SEO plays a significant challenge to promote information on such platform in presence of complicated connected nodes in social network. Such problem is addressed in Abu-Salih et al. [47] where it targets to find the social influencer on the basis of domain considering both machine learning and semantic analysis. Further study towards social network is also seen in work of Tey et al. [48] and Xu et al. [49] where a recommendation system is built. The work carried out by Serrano [50] has investigated the impact of deep learning for computing the learning relevance towards searching voluminous web-content. It is to be noted that a structured corpora is required for building effective SEO as noted in work of Tahir et al. [51]. The work carried out by Yuan et al. [52] have used a supervised learning approach for feature normalization in order to improvise the interaction process of web contents. Further work is also carried out by Zhou et al. [53] towards user preference and recommendation of video tags is carried out by Zhou et al. [54]. Table II highlights the summary of the work being discussed in this section.

TABLE II. SUMMARY OF SEO USING ML TECHNIQUES

Authors	Problems	Techniques	Advantage	Limitation
Boppana and Sandhya [35]	Error minimization during recommendation	RNN, clustering	Achieves 99.6% of accuracy	Domain specific implementation
Burgess et al. [36]	Malicious redirection	LSTM	Achieves 98.78% of accuracy	Induces to spatial complexity
Liu and Fu et al. [37]	Identification of insecure web-contents	Unsupervised feature learning	Achieves more than 95% of precision	Induces complexity associated with feature matching during validation
Soliman et al. [38]	Effective search of web-contents	Random forest	Achieves 92% of accuracy	Doesn't address prediction performance of retrieval of data
Ismail et al. [39]	Unstructured web-contents	Fuzzy Logic	Achieves 94% of accuracy	Higher dependency towards ruleset
Hisano et al. [40]	Prediction (use-case based)	Building network with heterogeneous data, weight learning	Improved accuracy	Case specific prediction of web-contents
Kim et al. [41]	Identification for highlights of multimedia file system	Deep learning using ranking	Category independent	Iterative process, not applicable for active SEO tool
Lister [42]	Adoption of knowledge contents	Pedagogy-based learning	Helpful for knowledge delivery system	The model lacks adoption of constraints
Peralta et al. [43]	Complex search process of educational content	Recommendation system using Probability, annotation of learning resources	Better performance for hybrid recommendation	No benchmarking computationally
Rahman and Abdullah [44]	Customization of educational contents	Profile-based learning system, decision tree	Effective learning outcomes on real-test	No benchmarking
Mahmood et al. [45]	Credibility analysis	Bayesian network (Feedback)	Good convergence performance	Applicable for smaller network of web.
Massaro et al. [46]	Intelligent score allocation of webpage	LSTM, Neural network	Simplified modelling	Restricted to smaller number of webpages
Abu-Salih et al. [47]	Extracting contextual contents of social network	Sentiment analysis, machine learning, retrieval of influencer, graphical approach	Capable of processing larger data	Domain-dependent implementation
Tey et al. [48]	Recommendation issue in social network	Personalized recommender	Simplified structural model	Not applicable for complex network
Xu et al. [49]	Personalized search and recommendation	Ontological similarity	Disambiguation in recommendation design	Model dependent on human intervention towards input feature
Serrano [50]	Investigational study towards neural network	Review study towards ranking and relevance of learning models	Random neural network to have higher scope	Doesn't specifically considered internal processing of SEO
Tahir et al. [51]	Reliable corpora building	Generation of corpora	Mean yield of crawling improves significantly	Specific to language
Yuan et al. [52]	Optimizing interaction of web contents	Supervised learning	Energy reduction	Assessed on one type of client application
Zhou [53]	Evaluation of ranking performance	Gain attribute learning	Minimize dependencies on labelling	Highly iterative scheme
Zhou [54]	Recommendation (video tag)	Deep learning	Scalable model	For smaller data

V. EXISTING SEO TOOLS

At present, there are various commercially available SEO tools which are meant to productively use time and effort towards performing data analysis and research. Some of the existing SEO tools commercially used are as follows:

A. Commercial SEO Tools

- *Ubersuggest*: This is a free SEO tool that is meant to determine the best suited keywords followed by concluding the intention behind it. It does so by exhibiting both the long and short phrases of top ranked webpage. An exclusive report is generated on the basis of trend analysis, degree of competition, and quantity of keywords [55].
- *Moz Pro*: This SEO tool is considered as one of the best products by experts owing to its up-to-date services even compared to Google services with search algorithm. Various beneficial response are facilitated to the user via its recommendation system. Apart from this, it also offers recommendation of various keywords that contribute towards increasing page ranking. Various web-metrics are retrieved from client application in order to assess its performance via this SEO tools [56].
- *KWFinder*: The prime motive of this SEO tool is to assist in evaluating all the keywords with long trail that has minimal competitive level. It can perform evaluation of ranking as well as enhancement of specific key metric in order to upgrade popularity of webpage [57].
- *SEMRush*: This is one of the most frequently used digital marketing tool which facilitates the user to verify the ranking of their webpage. It also performs feasibility analysis for new ranking as well as analysis among different domain. Therefore, it offers significant privilege to assess their services with that of competitors on the basis of analytical report [58].
- *Google Search Console*: This tool is freely available for all users facilitated by Google. This tool can be used for indexing the sitemap of the webpage by adding their code or via using Google Analytics. This SEO tool also let the user control about the indexing policies as well as it also controls the representation structure of the website. Apart from this, the complete visualization and usage aspect of the user can be controlled by this SEO tools [59].
- *Ahrefs*: This SEO tool is mainly used for online crawling of the websites. The core purpose of its usage resides in finding out the backlinks used by the competitor. Further, it is also used for exploring the contents with highest links as well as it can also repair the broken links to find out popular web-contents [60].
- *Serpstat*: This tool is used as a hacking platform for achieving goals of content marketing and SEO. It carries out all the task that is required for managing team to analyze the competitors. It also has an enriched

availability of competitor analyzed data as well as all the aggregated keywords [61].

- There are also various other commercially available SEO tools e.g., *Screaming Frog* [62], *Keywords Everywhere* [63], *Fat Rank* [64], *Siteliner* [65], *SEOquake* [66], *Google Trends* [67], *Majestic* [68], *Woorank* [69], *SpyFu* [70], etc. Further, information about the beneficial and limiting attributes of all the discussed commercially used SEO tools are as follows:

B. Beneficial Attributes Existing SEO Tools

The first advantage of majority of these SEO tools are that they are free of cost. The paid tools are based on usage patterns. Majority of them are reported to use local SEO tools in order to optimize the localized traffic. They are also mobile friendly as well as customer friendly while the recommendation services are based on experts.

C. Limiting Attributes Existing SEO Tools

A robust usage of SEO will yield a page with higher rank and this will also attract the attention of competitors. Hence, this is a continuous effort to be at top of rank, which is extremely challenging. There are fair feasibility of SEO to change which often causes uncertainty of consistency of ranks in upcoming times. The process of generation of response in SEO is quite a slower process. Even after frequent webpage updating, there is no assurance of timely results within a tentative duration of time.

VI. EXISTING RESEARCH TREND

At present, there are different categories of studies being undertaken for improving the performance of SEO. Table III highlights the research trends of using different standard approaches in SEO.

TABLE III. SUMMARY RESEARCH TRENDS ON SEP (2017-2022)

Items	Conference	Journal	Early Access Article	Books	Magazine
Total manuscript	298	70	12	3	3
NLP-based approach	2	10	0	0	0
ML-based approach	29	12	1	0	0
Miscellaneous	267	48	11	3	3

From Table III, it can be seen that there are very a smaller number of journal publications associated with both standard NLP and ML based approach in SEO as compared to miscellaneous approaches, which are normally application specific. The trend of minimal journal publication eventually means that both NLP and ML approach has just very a smaller number of research implementation in IEEE Xplore digital library. Similar trend of publication towards NLP and ML is also observed for other reputed publication of Elsevier, Springer, Wiley, etc. This concludes that there should be more attempts towards wholesome utilization of NLP and ML

approach for addressing the open-end research problems as illustrated in next section.

VII. RESEARCH GAP

After reviewing the existing approaches towards addressing the challenges in SEO, following research gap has been identified.

A. More Focus on Local Problems

A closer look into the existing approaches towards SEO shows that there are different variants of techniques in order to address specific set of problems or to cater up certain application demands. However, there is no existing framework, which can develop a solution towards addressing combined local problems over webpages e.g., duplicated contents, difference in performance in different computing device (e.g., PC, tablet, Smartphone), poor link building, inaccurate navigation system, not search friendly, inaccurate redirection, cluttered URLs, loading of page to be consuming high time, ignoring local search or not considering markup data. Although, all the above-mentioned problems have been individually found to be investigated, but they have not been combinedly addressed. Solving some of the local problems and ignoring the remaining of problems will eventually lead to impractical solution towards improving SEO.

B. Few Emphases Towards Content Generation

One of the targets of the SEO approach is to generate a precise content in order to meet the business objectives by reaching to maximum targeted customer. However, this is highly computationally challenging task. Existing approaches has evolved up with various techniques to ensure content quality, meta-data generation, and accuracy in its predictive approach. Such problems are mainly found to be solved using different variants of artificial intelligence and ML approaches. However, all such ML techniques suffer from serious drawbacks either of computational complexities or towards dependencies toward massive trained data. Existing ML approaches are also highly iterative and is mainly meant for passive mode of predictive operation. Therefore, they are less likely to be used for practical world application of SEO.

C. Few Studies Towards Smart Content Management

There is no doubt that ranking plays a significant role in SEO building process. However, such forms of ranking mechanism suffer from lower scale of adoption of objective function. Moreover, usage of existing deep learning scheme makes the process so much complicated and resource dependent that there is less scope of performing updating procedure. Without proper updating procedure, it is impossible to revise the solution being built for addressing local problems in SEO. At the same time, implementation of existing frameworks using NLP or ML will require serious re-engineering process, which is definitely not a cost-effective deployment scheme.

Hence, all the above-mentioned research gap are required to be bridged, without which a better form of SEO tool is impractical to be designed.

VIII. DISCUSSION AND RESEARCH IMPLICATIONS

In this survey work, the study explored the use of NLP and ML techniques in SEO. Through the literature review, it has been found that NLP techniques are particularly useful in improving the readability and quality of web content, while ML techniques are effective in analyzing various factors that influence search rankings. However, a combination of both techniques is often most effective, and there is a growing body of research on the integration of NLP and ML in SEO. This section delves deeper into the specific implications of these findings. The entire section includes discussing the practical implications of these findings for SEO practitioners and web content creators. Additionally, this section addresses challenges in the current research on NLP and ML for SEO, and suggests potential avenues for future research to address these issues.

A. Findings and Discussion

One of the most significant challenges in SEO is predicting and analyzing search engine algorithms. Based on the above-mentioned discussion it has been explored that, both NLP and ML techniques have been increasingly used in SEO to help search engines better understand the intent and meaning of web content, and to improve search rankings. One of the most common applications is the use of NLP to better understand search queries and match them with relevant content. It can be adopted to identify the underlying meaning and intent of search queries, and then match them with the most relevant content on the web. Another way that NLP techniques can be used in SEO is to improve the readability and quality of web content. Researchers have developed tools that use NLP to analyze the readability, grammar, and spelling of web content, and provide suggestions for improvement. On the other hand, ML techniques have been also be used to improve SEO in a number of ways. One of the most common applications is the use of ML to predict search rankings. Researchers have developed algorithms that use ML to analyze various factors that influence search rankings, such as keyword density, backlinks, and user engagement, and then make predictions on which websites are most likely to rank highly.

Irrespective of various number of research-based models being evolved, there are still an open-end problems associated with the performance of SEO. From commercial application viewpoint, existing studies don't promote towards potential links exploration while developing the model which will present the client webpage towards maximized rankings of search engine. The existing models do offer some solution to promote the popular content based on domain specific frameworks; however, there is lack of consistency towards the link building process. Irrespective of various study implementation using NLP, existing research work also doesn't seem to consider much of content management programs along with considering complexities of data within it. One such issue is presence of iterative tags of title, which still existing NLP is not able to address properly. The content management using NLP is required to be consistently updated, without which dynamic crawling could lead to ineffective convergence of search operation of web contents. Although, existing contribution of ML are quite notable; but they are also scattered as well as highly specific to use-cases. Hence, adoption of such models will be quite expensive and will require time-to-time

update and amendment based on business structure. At present, there is no generalized architecture or framework to address global problems all together. There is an increased proliferation in using different variants of ML approach towards optimizing various essential operation in building an effective SEO. However, existing ML approaches are mainly iterative, demands voluminous set of data, and doesn't have much consideration of multi-objective function along with adoption of practical constraints. This further reduces the scope of predictive approach and hence, existing SEO has not yet harnessed the full capabilities of ML approaches in order to gain a better result.

B. Remarks and Implications

It's difficult to determine which method is better, as both NLP and ML have their own strengths and weaknesses, and the choice of method will depend on the specific application and context.

NLP techniques are particularly useful in understanding the natural language used in search queries and web content. They can help search engines better understand the intent and meaning behind search queries, and can also improve the readability and quality of web content. However, NLP techniques may not be as effective in analyzing more quantitative factors, such as keyword density and backlinks, which are important for search rankings. On the other hand, ML techniques are particularly useful in analyzing large amounts of data and identifying patterns that are difficult for humans to detect. They can be used to analyze various factors that influence search rankings, such as keyword density, backlinks, and user engagement, and can make predictions on which websites are most likely to rank highly. However, ML techniques may not be as effective in analyzing the natural language used in search queries and web content.

While NLP and ML techniques are often used separately in SEO, there is also a growing body of research on the integration of these techniques. In many cases, a combination of both NLP and ML techniques may be most effective. For example, using NLP to better understand search queries and match them with relevant content, and using ML to predict search rankings based on a range of factors. Additionally, the effectiveness of either technique will depend on the quality of the data used and the specific algorithms and models used. Another area of research is the use of NLP and ML to identify and address black hat SEO techniques, such as keyword stuffing and link farming. An algorithm can be developed using NLP and ML to detect web content that has been artificially optimized for search engines and prevent websites from using them to manipulate search rankings.

Although, the use of NLP and ML in SEO offers numerous benefits, but it also has limitations, including the accuracy of the algorithms used and the cost of implementing technology. As ML and NLP technology continues to advance, it is likely that it will become increasingly essential in optimizing website ranking and visibility.

IX. CONCLUSION

This paper has investigated towards the performance improvement approaches from research viewpoint towards

developing a strong ecosystem of a holistic marketing. In this perspective, there are evolution of massive number of searches by the customers and digital marketers annually with an intention of fulfilling certain commercial targets. The prime outcome is to end up their search towards more relevant conclusive services or products. For this purpose, the webpage is required to be optimized for maximized ranking and higher visibility. Based on above learning outcomes, potential research gap is explored and the future work will be carried out towards addressing all the pitfalls of existing system as well as adopt all the beneficial points of the existing literatures. The first research gap is possible to be solved by developing a unique architecture integrating both NLP and ML approach, which will be capable to address majority of the local problems in building SEO using predictive page ranking approach. The second research gap can be solved by further improving the similar architecture and add novel functionalities towards efficient content generation process in SEO. A new variant of deep learning approach can be used with feedback connection over a tree-based network system. This will offer a capability to processes complete sequence of data available in web page. Focus will be also towards achieving better predictive generated data with lesser epoch values for confirming lower computational complexities. The third research gap can be addressed by further improving the same model using improved version of machine learning algorithm. In order to meet an optimization objective, a multi-objective function can be designed using three parameters i.e., state, reward, and actions in order to get more updated contents.

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