DESIDOC Journal of Library & Information Technology, Vol. 39, No. 1, January 2019, pp. 3-9, DOI : 10.14429/djlit.39.1.13692

Exploring Web Link Analysis of Websites of Indian Institute of Technology

Samir Kumar Jalal

Indian Institute of Technology, Kharagpur - 721 302, India
E-mail: skjalal@library.iitkgp.ac.in

ABSTRACT

Web links explore much useful information through densely linked web pages for a specific group of people or people with special research interest. The paper analyses the web link structure for a group of 23 IITs to discover new sources of information. It also discusses the problems of search engines and its limitations in web link analysis. Web link structures of Indian Institute of Technology (IITs) are analysed using SocSciBot4.0 and Pajek4. The paper tries to find out the pattern of hyperlinks among the premier IITs and new IITs separately. The study also covers the historical aspects and approaches of link analysis. Backlinks of IITs are analysed and micro-link topologies are constructed using Pajek. The result shows that more than 90 per cent of backlinks are in English language.

Keywords: Webometrics; IITs; India; Link analysis; Search engines; SocSciBot; Pajek

1. INTRODUCTION

The internet becomes popular due the magical power of the Web, the richest source of digital information. The information hosted on the Web is nothing but the collection of webpages connected through hyperlinks. Hyperlinks help the users to visit from one webpage to another. It means that hyperlinks explore the sources of information. Therefore, exploring web link leads to a new area of research[1]. It deals with the analysis and classification of hyperlinks and the study of links structure, which is extremely important because the web contents are increasing at an enormous speed. On the other hand, educational institutions are heavily dependent on their websites in delivering information. Sometimes, ranking agencies rank universities based on web indicators e.g. performance of websites, number of inlinks, number of webpages etc. Academic institutions are linked at each other through many parameters of different natures like research collaboration, project collaboration, authorship consortium etc. However, these relationships are measured through external links. Hence, link relationships among universities have been studied by a few researchers[2]. Through link analysis one can find out numerical score based on collective recommendations of millions of people[3]. The score indicates the quality of a document i.e. higher the score, the higher is the quality or authority of a document. Link analysis[4,5] primarily helps for effective information retrieval. It involves the identification of various links, co-links, co-inlinks, outlinks, link patterns, outlink coupling etc. There are various tools and software for extracting the link data. Link analysis is a technique to know hyperlink pattern among the institutes under study i.e. IITs based on the link data collected using commercial search engines and SocSciBot4, web crawlers and analysed through SocSciBot tools and Ucinet; link topologies are formed using network visualisation tools like Pajek, Netdraw etc. Web link analysis encompasses the identification of all types of links (inlinks, outlinks and self-links) of any websites or a particular domain. It may be noted that at present search engines are not supporting the link domain syntax since December 2011 but a few SEO tools (i.e. ahrefs and Majestic) are providing inlinks or backlinks data service.

Received : 9 October 2018, Revised : 13 December 2018
Accepted : 17 December 2018, Online published : 14 January 2019

2. HISTORY OF WEB LINK ANALYSIS

The research on web link analysis started from 1995-96 in the field of computer science[1], information science[6], and mathematics[7] for structure and complexity analysis. Further, Rousseau[8] opinion on the web information analysis and Almind & Ingwersen[9] web impact factor (WIF) and Rodriguez's web citation analysis made a remarkable progress in web link analysis. The WIF of Ingwersen[10] measured the impact of websites through the number of received links. WIF (external) being a measure of impact factor has a similarity with Google's Pagerank[11] proposed by Garfield[12] who made a comment that the WIF is "analogous to the citation impact factor (CIF)"[13].

WIF as an indicator of webometric research tries to evaluate top-level domains (TLDs) or second-level domains (SLDs)[14] and it is "analogous to citation counts in print environment"[15]. In print environment, citations establish the link between research publications whereas in digital environment, hyperlinks show the relation among varieties of publications like home page of institutions and publications, research article etc. However, anyone can set a link to other pages without quality control[16] and hyperlinks are not exactly

similar to citations in scholarly arena. The hyperlinks and webpages counts are the indicators of WIF. Self-citations are equivalent to self-links because links are coming from the same websites. Similarly, citations are replaced by web inlinks where links are coming from other websites of similar nature. Egghe[17] was not agreed this and pointed out that citations are very much different from hyperlinks as hyperlinks are synchronic but citations are diachronic. Deep link ratio (DLR) is the proportion of backlinks at TLDs to total number of backlinks for the entire website[18]. Shukla & Tripathi[19] made a study to examine backlinks; calculate deep link ratio, patterns of page pointing and patterns of link type relationship of 19 INPs using backlink analyser to measure the effectiveness and rank of the websites. The result revealed that technical institutes have higher backlinks than any other institutes. Hyperlink Induced topic search (HITS), a link-based algorithms was developed by Kleinberg[20] for link structure connectivity analysis. Two scores (hub score and authority score) are generally calculated in HITS. Resources having high authority scores have relevant content, whereas resources that have high hub scores are expected to contain links to relevant contents. Kleinberg[20] used weight of inlinks and outlinks to determine authority and hub score respectively. It's a fact that most of the search engines use HITS algorithm to find out most relevant web resources. PageRank[21] is another link analysis algorithm developed by Larry Page to measure the relative importance of webpage on the Web. It is calculated by the number of inbound links.

3. IIT SYSTEMS

Indian Institute of Technologies (IITs) are autonomous institute governed by Institute of Technology Act, I961 and these institutes are funded by MHRD, Govt. of India. At present, there are 23 IITs, which are grouped under 'old, 'medium', and 'new' on the basis of year of establishment. There are 7 IITs under old category and 8 IITs each under medium and new categories. IITs are autonomous educational institutions governed by IIT Act (1961). A few studies were conducted on WIF and link analysis of old IITs by researchers[22,23]. But the present study has attempted to conduct the link analysis in order to explore and visualise the link relationship among a group of 23 IITs.

Table 1 shows that there are seven old IITs established before 2001; eight medium IITs established between 2002 to 2010 and eight new IITs established between 2011 to 2018. Most of the north-estates like Maipur, Mizoram, Meghalaya, Arunachal Pradesh and Nagaland do not have IITs. Uttar Pradesh has two IITs. Ten new IITs failed to secure position in overall NIRF ranking in 2018.

4. OBJECTIVES

The main objective is to critically examine link analysis and link pattern of IITs and the effective use of web impact factors to know the relative strength of backlinks. The other associated objectives are as follows.

- To know the history and evolution of web link analysis research
- To calculate web impact factor of IITs to know their web performances
- To find out link patterns among the IITs in India
- To develop link topologies among IITs using webometric tools; and
- To know the status of backlinks of IITs and the distribution of incoming languages.

5. METHODOLOGY

For the purpose of link studies, a group of 15 IITs established before 2012 are considered for analysis and remaining 8 IITs established after 2013 are not considered for webometric study. The data on webpage have been collected on September 5, 2016 from Google using webometric query syntax, site: iitkgp.ac.in. For example, site: iitkgp.ac.in under Google query reflects the result that there are 242000 webpages retrieved in 0.28 seconds. The data on visibility was collected from SEO tools i.e. Majestic SEO[18] and ahrefs during the period**.** Table 1 shows the list of IITs with domain name, date of establishment, states in which they belong to and overall

Table1. List of IITs as on July 31, 2018 (based on NIFR overall ranking)

Name	Yr. of estd.	Domain name	States	NIRF rank18	Status
IIT Kharagpur	1951	iitkgp.ac.in	West Bengal	5	Old
IIT Bombay	1958	iitb.ac.in	Maharashtra	3	Old
IIT Madras	1959	iitm.ac.in	Tamil Nadu	2	Old
IIT Kanpur	1959	iitk.ac.in	Uttar Pradesh	7	Old
IIT Delhi	1963	iitd.ac.in	Delhi	4	Old
IIT Guwahati	1994	iitg.ac.in	Assam	12	Old
IIT Roorkee	2001	iitr.ac.in	Uttarakhand	8	Old
IIT Bhubneswar	2008	iitbbs.ac.in	Odisha	51	Medium
IIT Gandhinagar	2008	iitgn.ac.in	Gujrat	39	Medium
IIT Hyderabad	2008	iith.ac.in	Andhra Pradesh	22	Medium
IIT Jodhpur	2008	iitj.ac.in	Rajasthan	Nil	Medium
IIT Patna	2008	iitp.ac.in	Bihar	69	Medium
IIT Ropar	2008	iitrpr.ac.in	Punjab	Nil	Medium
IIT Indore	2009	iiti.ac.in	Madhya Pradesh	Nil	Medium
IIT Mandi	2009	iitmandi.ac.in	Himachal Pradesh	Nil	Medium
IIT (BHU) Varanasi	2012	iitbhu.ac.in	Uttar Pradesh	28	New
IIT Palakad	2015	iitpkd.ac.in	Kerala	Nil	New
IIT Tirupati	2015	iittp.ac.in	Andhra Pradesh	Nil	New
IIT Dhanbad	2016	iitism.ac.in	Jharkhand	27	New
IIT Bhilai	2016	iitbhilai.ac.in	Chhattishgarh	Nil	New
IIT Goa	2016	iitgoa.ac.in	Goa	Nil	New
IIT Jammu	2016	iitjammu.ac.in	J& K	Nil	New
IIT Dharwad	2016	iitdh.ac.in	Karnataka	Nil	New

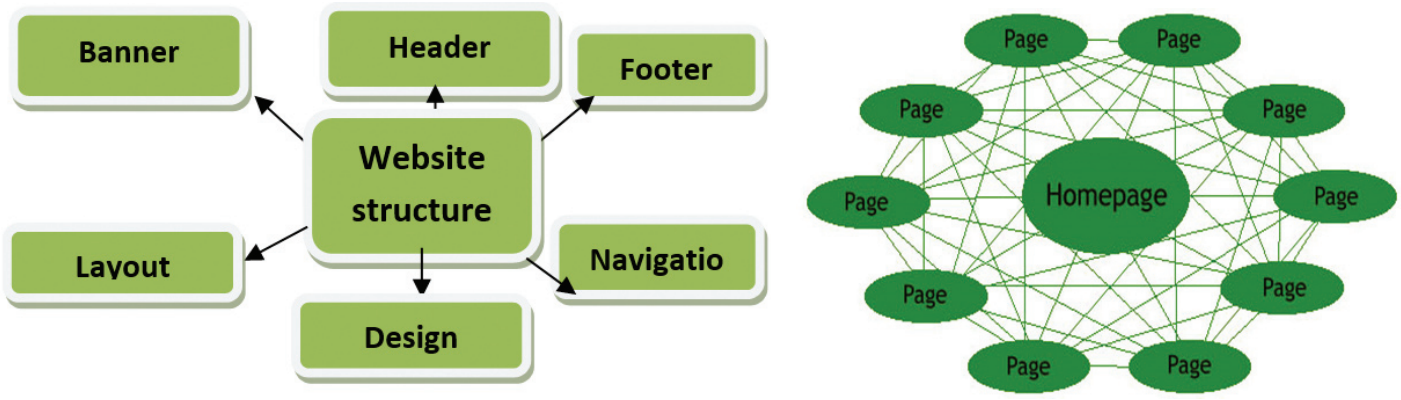

Figure 1. (a) Structure of website, (b) Link structure.

rank as per National Institutional Ranking Framework (NIRF) 2018. The data was collected as it was having free membership in 2016. But, ahref is now rendering its service on payment basis. There are three type of WIF (self-link, external link and overall). WIF is calculated by dividing the number of backlinks by number of webpages at the site. On the other hand, each website of IITs was crawled through SocScibot4 and the crawled data were analysed through SocSciBot tools to form the micro-link topology as shown in Fig. 2.

6. WEB LINK STRUCTURE-INTERNAL LINKS AND EXTERNAL LINKS

Webpages are inter-connected at each other through hyperlinks. These links are generally of two type: Internal /self-links and external links. Self-links are those, which go from one page on a domain (iitkgp.ac.in) to a different page on the same domain (i.e. iitkgp.ac.in). The syntax for internal links: admission.

The appropriate use of keyword in anchor text helps the search engine to find out for web text analysis and insists for getting more and more external links for a domain. These internal links are helpful because: these links helps to organise the website; maintain information hierarchy; assists the search engines to crawl webpages; and browse the information within a website. The study also helps for the researchers and web masters while planning to develop a website because well planned and well organised internal links help to accumulate inbound links.

Figure 1(a)&1(b) clearly exhibit the link structure (internal) and the components of website structure. Webmaster should take care of various aspects while designing the websites.

7. ANALYSIS AND RESULTS

7.1 Calculation of WIF

Table 2. Calculation of WIF for seven old IITs based on data collected in 2016

Name	Webpages	Crawled pages	Backlinks	WIF_{ahref}	WIF_{Google}
	Google	ahrefs			
IIT Bombay	365000	388800	6,36488	1.64	1.74
IIT Madras	354000	297178	10,00830	3.37	2.83
IIT Kanpur	422000	2323944	4,45525	0.19	1.06
IIT Delhi	99800	215386	1,56674	0.73	1.57
IIT Kharagpur	242000	105726	77581	0.73	0.32
IIT Guwahati	7530	9409	1,29300	13.74	17.17
IIT Roorkee	11700	11045	43130	3.90	3.69

Table 3. Calculation of WIF of New IITs based on data collected in 2016

Name	Webpages	Crawled pages	Backlinks	WIF_{ahref}	WIF_{Google}
IIT Bhubneswar	3800	2263	7096	3.14	1.87
IIT Gandhinagar	50500	91134	11022	0.12	0.22
IIT Hyderabad	19900	10833	12707	1.17	0.64
IIT Jodhpur	20700	2977	12655	4.25	0.61
IIT Patna	2830	24290	562682	23.17	198.83
IIT Ropar	3380	3619	8495	2.35	2.51
IIT Indore	3510	2856	8109	2.84	2.31
IIT Mandi	3090	4127	9611	2.33	3.11

The data on webpages have been collected from Google search engines using query “site:” e.g site: iitb.ac.in. The search query was run on September 5, 2016. IIT Kanpur was having the highest number of webpages i.e.422000; whereas the same for IIT Guwahati was the lowest one i.e. 7530.

Table 2 describes that IIT Guwahati has the highest WIF based on ahref data and Google data due to less number of webpages. But, number of backlinks as retrieved from ahref was the highest for IIT Madras followed by IIT Bombay and IIT Kanpur. This has an influence on ranking of the institute by

Table 4. Link analysis with values for 15 IITs in 2016

Name	Referring page	Backlinks	Crawled pages	Referring IPs	Referring subnets	Referring domains
IIT Bombay	497,388	636,488	388800	13055	9585	16798
IIT Madras	742753	1000830	297178	7847	6294	9446
IIT Kanpur	356506	445525	2323944	8312	6656	10080
IIT Delhi	136736	156674	215386	4089	3322	5173
IIT Kharagpur	63507	77581	105726	2788	2266	3610
IIT Guwahati	125395	129300	9409	1335	1129	1673
IIT Roorkee	39715	43130	11045	1783	1455	2253
IIT Bhubneswar	6315	7096	2263	659	572	817
IIT Gandhinagar	9860	11022	91134	834	730	1099
IIT Hyderabad	11344	12707	10833	884	765	1069
IIT Jodhpur	4159	12655	2977	633	550	783
IIT Patna	561872	562682	24290	586	525	700
IIT Ropar	7146	8495	3619	709	639	827
IIT Indore	7057	8109	2856	616	543	749
IIT Mandi	8694	9611	4127	574	494	685

Source: http://ahrefs.com, data collected on 18th August 2016

Table 5. ADM count summary for old IITs

	Inlinks				Outlinks			
Domain	Page	Directory	Domain	Site	Page	Directory	Domain	Site
iitk.ac.in	112	65	36	5	186	30	26	6
iitd.ac.in	70	50	21	5	221	61	42	6
iitm.ac.in	103	71	33	6	0	0	0	0
iitb.ac.in	4467	78	38	5	92	91	29	6
iitg.ac.in	38	20	19	5	86	37	24	6
iitkgp.ac.in	39	21	18	5	3948	66	34	6
iitr.ac.in	37	19	16	5	333	39	26	6

Ranking Web of Universities, Cybermetrics Lab, Spain.

IIT Gandhinagar has the highest number of webpages (50,500) whereas IIT Patna shows the lowest (2,830) webpages among medium IITs but IIT Patna witnessed the highest number of backlinks (5,62,682) consequently IIT Patna scored the highest WIF among the new IITs.

7.2 Classification of Link Pages

There are a few categories of link pages as shown below:

- Referring Pages are the external webpages containing at least one backlink that links to iitkgp.ernet.in or any sub domain
- Total Backlinks are external backlinks found on referring pages that link to iitkgp.ernet.in or any sub-domain
- Crawled Pages are unique pages visited by ahrefs crawler on iitkgp.ernet.in. These pages are stored in the index to build all reports
- Referring IPs are unique IP addresses containing at least one backlink that links to iitkgp.ernet.in or any subdomain
- Referring Subnets are unique IP subnet address containing at least one backlink that links to iitkgp.ernet.in or any subdomain
- Referring Domains are domains containing at least one backlink that links to iitkgp.ernet.in.

7.3 Alternative Document Model (ADM) Count Summary

Link data are collected through commercial search engines and academic web crawler to overcome the problem of search engine. Generally, crawler starts from the homepage of a university website extracts its entire links and download all of pages having links to it. Academic web crawlers comprehensively cover individual website within specified parameter[2]. One of the limitations of web crawler is that it is not possible to cover large web study. In order to avoid biasness in data collection ADM approach is proposed by Mike Thelwall[27] for data collection. ADMs have four components e.g. page level, directory level, domain level and university level in general. Page level is the original link data which is converted into page link data by reducing the urls; Link data transformed into directory link data by truncating before the last slash of the urls; Domain links are link data which are transformed into link by truncating the page and link urls after the first slash. Whole university model may be considered as the unit to count the links;

ADM count summary provides the useful information for link analysis and original link data yields page link data by truncating urls**.** Page counts, directory counts and file counts of IITs have also been calculated to know the interlinking status among the IITs.

7.4 Network Diagram of IIT Delhi Website

Network diagram was built based on the ADM count summary data at the page level, directory level and file level after the crawling the data through web crawler, SocSciBot (developed by Mike Thelwall). Since Pajek is integrated with the software so the network graphs (Fig. 2) may be generated. Fig. 2 shows the micro-link topology of IIT Delhi and such link topologies can be generated to show the network diagram of IITs (combined) and other IITs in similar fashion; the combined network diagram (it is not shown here because of complicated network structure and visibility issue due to huge links) helps

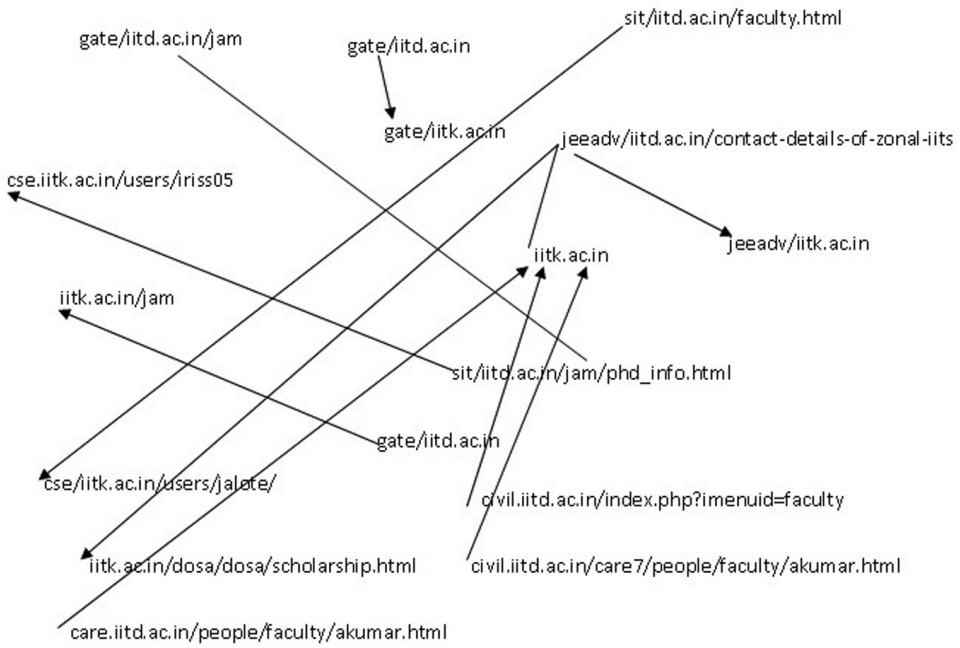

Figure 2. Network diagram of IIT Delhi website.

Table 6. Lists top 10 links received from IIT Delhi and IIT Bombay respectively

www.iitd.ac.in (IIT Delhi)		www.iitb.ac.in (IIT Bombay)	
Links	**URLs**	**Links**	**URLs**
150	http://iitb.ac.in/rti-home	28	http://paniit.iitd.ac.in/indest/
10	http://nptel.iitm.ac.in/	27	http://nptel.iitm.ac.in/
8	http://iitm.ac.in/	4	http://iitm.ac.in/
7	http://iitb.ac.in/	4	http://iitr.ac.in/
7	http://iitk.ac.in/	4	http://iitk.ac.in/
5	http://iitr.ac.in/	3	http://iitkgp.ac.in/
4	http://iitkgp.ac.in/	3	http://iitd.ac.in/
4	http://jeeadv.iitb.ac.in/	2	http://jeeadv.iitkgp.ac.in/
3	http://iitg.ac.in/	2	http://jeeadv.iitk.ac.in/
1	http://ee.iitm.ac.in/	2	http://jeeadv.iitr.ac.in/

to know which IIT is providing links to whom. Fig. 2 is the network diagram of IIT Delhi website, where internal and external links were shown through the undirected and directed graph respectively.

7.5 Text Analysis

Text analysis technique is applied to the downloaded data for the selected websites under study using SocScibot4. Cyclist search engine is a text analyser tool which is integrated with SocSciBot4.0 and helps to build up the word frequency statistics. Cyclist also provides the search interface for searching a particular text keyword. Therefore, cyclist is very useful tool for text analysis based on the crawled data.

7.6 Language Analysis

Majestic is another SEO tool for webometric analysis where incoming links and metrics were split into with the help of Site Explorer. It is possible to login to the majestic.com and collect a sample data for domains under study. The external backlinks and the percentage of incoming languages for the external backlinks have been collected. Language analysis is also important for the website to realise the actual use of the website.

Table 7 shows that more than 90 per cent backlinks are with English languages, which is the dominating language in the web followed by Hindi for the case of Indian websites. Some of the cell values in Table 7 show null, which indicates that there is no significant results.

8. FINDINGS OF THE STUDY

Some of the findings of the study are as follows:

- Original link data are transformed into page link data by truncating the URLs**.** Pages and link counts of IITs and directory interlinking among IITs have been shown in Fig. 2.
- The study shows that more than 90 per cent backlinks are with English languages. Incoming language under the distribution of backlinks revealed that IIT Bombay has significant percentage of Hindi (13.80 %) as well as Marathi (18.70 %) language
- IIT Gauhati, among the old IITs, has the highest number of ahref-web impact factor (13.74) as well as Google WIF (17.17)
- IIT Gandhinagar, among medium group, has the highest number of webpages whereas IIT Patna has the highest number of backlinks
- There is a strong correlation between ahref-WIF and Google-WIF
- Cyclist being integrated with SocSciBot 4 is a useful tool for text analysis based on the crawled data.

9. CONCLUSIONS

Web links analysis has been conducted individually and in a group among IITs. Web link structure analysis has two important phases' i.e. internal links structure analysis and external link structure analysis. The study has clearly found the microstructure (for single IIT) and pattern of web links for a group of IITs (combined). An attempt has been taken to find out the micro-link topologies of IIT Delhi. ADM count summary using SocSciBot produced link matrices, which gives an indication of interconnectivity through hyperlinks. The study may help other researchers to conduct similar studies for other institutes. The crawled data through SocSciBot4 helped to know internal file and directory structure of the websites.

Table 7. Distribution of external backlinks and incoming languages

Name	Domain	External backlinks	Incoming language (%)				
			English	Hindi	Russian/ Spanish	Marathi	Kanada
IIT Bombay	iitb.ac.in	6666104	66.90	13.80	0.01	18.70	-
IIT Madras	iitm.ac.in	2597816	98.50	0.20	0.10	0.00	-
IIT Kanpur	iitk.ac.in	3948374	97.1	2	-	-	0.3
IIT Delhi	iitd.ac.in	3500455	99.8	0.1	-	-	-
IIT Kharagpur	iitkgp.ac.in	2966377	82.00	16.90	0.60	0.00	-
IIT Gauhati	iitg.ac.in	1309984	99.1	0.7	-	-	-
IIT Roorke	iitr.ac.in	1766322	99.4	0.3	-	-	-

Source: http://majestic.com

Text analysis and keyword analysis process have been shown using Cyclist search. In sort, web link analysis helps to evaluate search engines, improves the security aspects of websites, an initiative for search engine optimisation, finding out missing links, to know the external and internal link errors and many more. The study on link analysis of a website definitely be a good guidance to the webmaster and web administrator for improving the performances of the website. Text analysis through hyperlinks using open source software like cyclist etc using topical random walk model[28], HIST algorithm and PageRank techniques can give a direction for building network link structure for a group of institutions. It is true that web link analysis has tremendous influence on enhancing the information retrieval through using appropriate text anchor, keywords and other techniques.

REFERENCES

1. Weiss. HyPursuit: A hierarchical network search engine That exploits content-link hypertext clustering. *In* Proceeding HYPERTEXT '96 Proceedings of seventh ACM conference on Hypertext, Bethesda, Maryland, USA, March 16-20, 1996, 180-193.
2. Jalal, S.K.; Biswas, S.C. & Mukhopadhyay, P. Web impact factor and link analysis of selected Indian universities. *Ann. Libr. Inf. Stud*., 2010, **57**(2), 109-121.
3. Bjelland, J.; Canright, G.S.; Engø-monsen, K. & Engø- K. Web link analysis : Estimating a document's importance from its Context. *World Wide Web Internet Web Inf Syst.,* 2008, 95-113.
4. Vaughan, L. & Ninkov, A. A new approach to web co-link analysis. *J. Assoc. Inf. Sci. Technol*., 2018, **69**(6), 820-831.
   doi: 10.1002/asi.24000
5. Thelwall, M. A comparison of sources of links for academic Web impact factor calculations. *J. Doc.*, 2002, **58**(1), 66-78.
   doi: 10.1108/00220410210425412
6. Bossy, M. The last of the litter : Netometrics. *Solaris,* 1995, **2**. http://gabriel.gallezot.free.fr/Solaris/d02/2bossy.html.(accessed on 23 September, 2018)
7. Abraham, R.H. Webometry: Measuring the complexity of the world wide web. *World Futures,* 1997, **50**(1-4),785-791.
   doi: 10.1080/02604027.1997.9972670
8. Rousseau, R. Sitation: An exploratory study. *Cybermetrics*, 1997, **1**(1), 1.
9. Almind, T.C. & Ingwersen, P. Informetric analyses on the world wide web: Methodological approaches to 'Webometrics,' *J. Doc.*, 1997, **53**(4), 404-426.
10. Ingwersen, P. The calculation of web impact factors. *J. Doc.*, 1998, **54**(2), 236-243.
    doi: 10.1108/EUM0000000007167
11. Brin, S. & Page, L. The anatomy of a search engine. *In* Proc 7th Int World-Wide Web Conf. 1998, **30**(1-7), 20.
    doi: 10.1016/S0169-7552(98)00110-X
12. Garfield, E. The impact factor. *Current Contents*, 1994.
13. Garfield, E. How can impact factors be improved? *BMJ*, 1996, **313**(7054), 411-413.
    doi: 10.1136/BMJ.313.7054.411
14. Mukhopadhyay, P. Measuring web impact factors: A webometric study based on the analysis of hyperlinks. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.626.8019&rep=rep1&type=pdf (accessed on 2 October, 2018).
15. Smith, A.G. Web links as analogues of citations. *Inf. Res. Int. Electron. J.,* 2004, **9**(4). http://www.informationr.net/ir/9-4/paper188.html (accessed 23 September 2018).
16. Vaughan, L. The wall M. Scholarly use of the Web: What are the key. *J. Am. Soc. Inf. Sci. Technol*., 2003, **54,** 29-38.
17. Egghe, L. New informetric aspects of the Internet: Some reflections - many problems. *J. Inf. Sci.,* 2000, **26**(5), 329-335.
    doi: 10.1177/016555150002600505
18. Deep link ratio analyzer tool. https://www.seroundtable.com/archives/001826.html. (accessed on 6 October, 2018).
19. Shukla, A. & Tripathy, A. Webometric analysis of institutes of national importance in India, *IASLIC Bull.,* 2009, **54**(3), 165-180.
20. Kleinberg, J.M. Authoritative sources in a hyperlinked environment. New York; 1999. www.harvard.edu. (accessed on 23 September 2018).
21. PageRank. https://en.wikipedia.org/wiki/PageRank (accessed on 6 October 2018)
22. Mukhopadhyay, P. P. Measuring web impact factors: A webometric study based on the analysis of hyperlinks. citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.626

.8019&rep=rep1&type=pdf. (Accessed on 23 September 2018).
23. Maharana, R.K.; Panda, K.C.; & Sahoo J. Web impact factor (WIF) and link analysis of indian institute of technologies (IITs): A webometric study. *Lib. Philos. Pract*., 2012, **789**.
doi: http://digitalcommons.unl.edu/libphilprac/789/
24. Jalal, S.K.; Biswas, S.C. & Mukhopadhyay, P. Webometric analysis of central universities in India: A study. *In* International Conference for Internet Technology and Secured Transactions, ICITST 2009, 2009.
25. Thelwall, M. Bibliometrics to webometrics, *J. Inf. Sci.,* 2008, **34**(4), 605-621.
doi: 10.1177/0165551507087238
26. Thelwall, M. & Kousha K. Web indicators for research evaluation. Part 1: Citations and links to academic articles from the Web. *El. Prof. la. Inf.* 2015, **24**(5), 587-606.
doi: 10.3145/epi.2015.sep.08
27. Thelwall, M.; Vaughan, L. & Björneborn, L. Webometrics. *Annu. Rev. Inf. Sci. Technol*., 2005, **39**, 81-135.
28. Nie, L.; Davison, B.D. & Qi, X. Topical link analysis for web search. *In* Proceedings of the 29th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval-SIGIR '06. New York, USA: ACM Press; 2006, **91**.
doi: 10.1145/1148170.1148189.

CONTRIBUTOR

Dr Samir Kumar Jalal did MA (Economics) and BLIS from Rabindra Bharati University, in 1996 and 1998, respectively and Associateship in Documentation and Information Science from DRTC, Indian Statistical Institute, Bangalore, in 2001. He did PhD in Library & Information Science from The University of Burdwan. Currently, he is working as Deputy Librarian at Central Library, IIT Kharagpur since October 2014. He has published 47 paper in Journals and Conference Proceedings.