

Webometrics Ranking of Universities in Nigeria. Using Enhanced Recursive Ranking Algorithm (ERRA),

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ABSTRACT

We demonstrated the applicability of our proposed algorithm by using the Webometrics Ranking of universities in Nigeria. To test the validity and effectiveness of our proposed Enhanced Recursive Ranking Algorithm (ERRA), we applied the algorithm to the ranking of Nigerian universities and compared the results to Webometrics University Ranking of the same institutions. The Ranking dataset of 100 Nigerian Universities was obtained from 2016 Webometric ranking data. The ranking positions of the universities were based on four ranking criteria (Presence, Openness, Impact, and Excellence). These criteria were normalized to generate weighted criteria scores. Users were required to specify the relative importance of this criteria as input values. Using the weighted normalized values of these criteria, the search results were ranked by our algorithm. We report the results and findings from our experiment in this paper

Keywords: Webometrics Ranking, Universities, Nigeria, Enhanced Recursive Ranking Algorithm (ERRA),

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1. INTRODUCTION

The Webometrics University Ranking is a ranking system based on university web presence, visibility and web access.[2] This ranking system measures how strongly a university is present in the web by its own web domain, subpages, rich files, scholarly articles etc.[1, 2] The central hypothesis of this approach is that web presence is a reliable indicator of the global performance and prestige of the universities and as such, is an indirect way to measure all the university missions (teaching, research, transfer). Although the Web is universally recognized as one of the most relevant tools for scholarly communication, it is still very rare these indicators are used for the evaluation of the scientific research and the academic performance of universities. Webometric indicators are provided to show the commitment of the institutions to Web publication [2]. A research paper in the peer-reviewed scientific journal Scientometrics found "reasonable similarities" between the Webometrics rankings and other prominent university rankings despite using a very different set of features to determine each university's rank. These similarities were increased when the comparison was limited solely to European universities. Top universities are publishing millions of pages produced by dozens of departments and services, hundreds of research teams and thousands of scholars. Strong web presence informs of a wide variety of factors that are clearly correlated with the global quality of the institution: widespread availability of computer resources available, global internet literacy, policies promoting democracy and freedom of speech, competition for international visibility or support of open access initiatives, among others [7]



We attempt to develop a new ranking algorithm that ranks results according to how closely they match user-specified traits. The algorithm allowed users to specify search criteria in order of relative importance to their search for people, publications, records, etc. on the Web, social networks, citation databases, and so on. We demonstrated the applicability of our proposed algorithm by using the Webometrics Ranking of universities in Nigeria. To test the validity and effectiveness of our proposed Enhanced Recursive Ranking Algorithm (ERRA), we applied the algorithm to the ranking of Nigerian universities and compared the results to Webometrics University Ranking of the same institutions. The Ranking dataset of 100 Nigerian Universities was obtained from 2016 Webometric ranking data. The ranking positions of the universities were based on four ranking criteria (Presence, Openness, Impact, and Excellence) [8]

2. DATASET GATHERING AND SELECTION

Our review requires a well-structured and standardized dataset for the testing of our algorithm. A key feature of the dataset is that the criteria must be scientifically proven and having wide acceptance. Several datasets were considered for to test our algorithm but most criteria did not pass the test of general acceptability. In the ranking of Nigerian universities for example, criteria such as employability of the graduates and rating of the faculty staff are great criteria. However, we could not find a standardized scientifically proven data/record of ranking of Nigerian universities using these criteria. As a result of this fundamental consideration, Webometric ranking of World universities provided us with the most suitable options [3,4,5]. Webometric ranking is based on four criteria namely; Presence, Openness, Impact, and Excellence. Data for these criteria are standardized, scientifically generated and possess wide acceptability. Brief explanation of these criteria are as follows:

Presence: In webometrics ranking, presence refers to the general activities of the universities on the internet with consideration for the total number of webpages hosted on the web domain of each university as indexed by Google. This criteria takes into consideration all webpage format recognized by Google including static and dynamics. Presence weighted score in webometric is 20% of the overall criteria. This often reflects the general performance of the universities globally [12, 11].

Openness: This criteria takes into consideration the recent publications of the universities in scholarly recognized platforms such as Google scholar. The number of PDF, DOC, PPT, and DOCX etc. published in dedicated websites is taken in consideration. Openness weighted score in webometric is 15%.

Impact: The impact criteria refers to the quality of the contents which is accessed on the basis of the number of external backlinks that the university web domain received from third parties researchers. This helps measure the prestige of the institution, the academic performance, the usefulness and values of the information based on the references from millions of web editors across the world. Impact weighted score in webometric is 50%.

Excellence: This depends on the number of academic papers that are published in high reputable impact international journals. This does not just measure the volume or umbers of publication but with special focus on publications only in reputable scholarly international journals. For scientific outputs to be considered under excellence, the output has to be part of the 10% of the most cited papers in their scientific field. Excellence weighted score in webometric is 15%.[9,10]



Table 1: Criteria, Meaning and Weight

CRITERIA	MEANING	WEIGHT
Presence	No of webpages hosted in the main web domain	20%
Openness	No of papers (DOC, PDF, DOCX and PPT)	15%
Impact	Quality of the contents (No of backlink)	50%
Excellence	No of quality papers published in reputable journals	15%

Webometric Criteria





Table 1 shows a brief summary of the indicators used by webometric in the 2016 edition of ranking of world universities. Based on the table, impact has the highest percentage, accounting for 50% of the entire indicators. This follows by presence which has 20% while openness and excellence were rated equally at 15% each. Similar information is presented in fig 1 but in a different graphical representation. All these indicators we rigorously determined, scientifically proving being a product of intense research work. As a result, it present the best fit as dataset for testing our algorithm. Webometric ranks over 28000 universities across all nations of the world. This present a huge amount of data and is a source of dataset for many educational data analytics. In this research work, we focused on the dataset for top 100 Nigerian universities and academic institutions. Table 2 shows the raw dataset from webometric 2016 ranking for the top 100 Nigerians educational institutions.



Table 2: Webometric Ranking for Nigerian Universities

Ranking	World Ranking	University	Presence Rank	Impact Rank	Openness Rank	Excellence Rank
1	1335	University of Ibadan	3446	1302	1612	1715
2	1788	Covenant University Ota	1662	1621	1943	2685
3	1986	Obafemi Awolowo University	1276	2542	2519	2534
4	2613	University of Lagos	2005	6118	2329	2521
5	2652	University of Nigeria	2986	5817	1424	2805
6	2840	University of Port Harcourt	8692	3231	2274	3459
7	2914	University of Agriculture Abeokuta	2854	5429	2480	3125
8	2985	University of Ilorin	5467	6332	2110	2941
9	3049	Ahmadu Bello University	4180	8499	2557	2546
10	3214	Federal University of Technology Owerri	14969	2447	4016	3860
11	3507	Federal University of Technology Akure	4814	9897	3087	2894
12	3513	Federal University of Technology Minna	10700	7827	2915	3125
13	3542	University of Benin	5311	7705	2655	3506
14	4064	University of Abuja	4516	3824	3863	5228
15	4070	Afe Babalola University Ado Ekiti	3181	3619	1819	5778
16	4075	Ladoke Akintola University of Technology	3999	11254	2551	3617
17	4119	Bayero University Kano	16937	8789	3151	3459
18	4291	University of Jos	3620	10219	3672	3939
19	4306	University of Uyo	22465	11467	2921	2751
20	4313	Nnamdi Azikiwe University	10289	11286	2259	3617
21	4340	University of Calabar	6649	12959	2446	3381
22	4860	Lagos State University	16003	11750	3231	3617
23	5008	University of Maiduguri	14423	12360	4189	3506
24	5496	Landmark University	4050	6705	4037	5778
25	5529	(1) Michael Okpara University of Agriculture U	16325	6357	4195	5228
26	5686	Olabisi Onabanjo University (Ogun State Unive	9622	13357	4337	4032
27	5822	Babcock University	1887	8399	4064	5778
28	6197	Rivers State University of Science & Technolog	16255	12420	3480	4330
29	6226	Federal University Oye Ekiti Ekiti State	4156	8375	4341	5778
30	6745	African University of Science & Technology Ab	4900	14202	6984	4142
31	7022	Adekunle Ajasin University	15553	12937	4639	4482
32	7242	(1) Ebonyi State University	20521	13776	4152	4244



Ranking	World Ranking	University	Presence Rank	Impact Rank	Openness Rank	Excellence Rank
33	7697	American University of Nigeria	5903	10546	5191	5778
34	7738	Federal University Dutsin Ma	11854	9989	4392	5778
35	7967	Niger Delta University	17988	14669	4915	4330
36	8090	Ekiti State University Ado Ekiti (University of A	15404	12273	4124	5228
37	8182	Redeemer's University	10572	11778	3294	5778
38	8225	Auchi Polytechnic	11786	5146	8635	5778
39	8239	Osun State University	9047	12050	3472	5778
40	8503	Usmanu Danfodiyo University	12198	13076	4879	5228
41	8617	Enugu State University of Science & Technolog	14398	10042	5385	5778
42	9202	Federal University Ndufu Alike Ikwo FUNAI	17193	11613	3558	5778
43	9734	Benue State University	21010	13856	5307	4916
44	9806	Ambrose Alli University Ekpoma	11150	14072	6246	5228
45	9868	Kwara State University	13455	12103	5216	5778
46	10045	Abubakar Tafawa Balewa University	22160	13268	4416	5228
47	10720	Fountain University Osogbo	3820	15868	4729	5778
48	10976	Lagos Business School Pan Atlantic University	5644	10280	8635	5778
49	11005	Federal University of Agriculture Makurdi	18652	13996	6251	5228
50	11020	Lead City University Ibadan	19015	11903	5823	5778
51	11142	Abia State University Uturu	25336	16272	5430	4330
52	11254	National Open University of Nigeria	12119	9293	8635	5778
53	11288	Umaru Musa Yar'Adua University (Katsina State	14523	13856	5191	5778
54	11442	Edo State Polytechnic Usen	21367	7339	8635	5778
55	11549	Delta State University Nigeria	20390	13391	4475	5778
56	11573	Polytechnic Ibadan	17391	10648	7896	5778
57	11799	Federal University of Technology Yola	20879	16059	4475	5228
58	11880	Ajayi Crowther University Oyo	12729	13724	6698	5778
59	11927	Yaba College of Technology	14441	10261	8514	5778
60	11956	Nigerian Defence Academy Kaduna	17559	13076	6284	5778
61	12015	Federal University Dutse Jigawa State	8928	15174	6300	5778
62	12015	Federal University of Petroleum Resources Eff	21445	14407	6561	5228
63	12178	Cross River State University of Science & Tech	18238	15250	8514	4482
64	12216	Bowen University	16909	13296	6625	5778
65	12230	Bingham University New Karu	21631	12306	6491	5778
66	12356	Federal University Lokoja Kogi State	11009	15501	5975	5778
67	12492	Joseph Ayo Babalola University	17741	15094	7357	5228
68	12537	Elizade University Ilara Mokin	7498	17333	4966	5778
69	12677	Pan African University Lagos	20638	12640	6975	5778
70	12778	Air Force Institute of Technology	24006	18687	1592	5228
71	12803	Nasarawa State University	18908	14995	5184	5778



Ranking	World Ranking	University	Presence Rank	Impact Rank	Openness Rank	Excellence Rank
72	12995	Federal University Otuoke Bayelsa	17164	14429	6578	5778
73	13484	Federal University Lafia Nasarawa State	15475	16395	5631	5778
74	13515	Igbinedion University Okada	21393	14313	6403	5778
75	13611	Akwa Ibom State University of Technology	20660	16059	4780	5778
76	13695	Ondo State University of Science & Technolog	19651	14467	6935	5778
77	13764	Ibrahim Badamasi Babangida University Lapai	21422	15868	5036	5778
78	13817	Tai Solarin University of Education	13336	14234	8147	5778
79	14067	Imo State University Owerri	21095	13493	8635	5228
80	14147	Benson Idahosa University	16860	16839	5856	5778
81	14147	Federal University Wukari Taraba State	20267	17042	4620	5778
82	14298	Al Hikmah University Ilorin	21117	16636	5161	5778
83	14443	Federal Polytechnic Ilaro	20796	15573	6686	5778
84	14734	Kogi State University	14577	13622	8635	5778
85	14746	Nigerian Turkish Nile University Abuja	21021	14549	7755	5778
86	14879	Petroleum Training Institute Effurun	20056	12509	8635	5778
87	14913	Madonna University Nigeria	20660	12412	8635	5778
88	15012	Kaduna Polytechnic	19692	15337	7697	5778
89	15133	Paul University Awka Anambra State	19853	12909	8635	5778
90	15325	Baze University Kuchigoro	14295	17672	7223	5778
91	15426	Bauchi State University Gadau	13263	18818	6543	5778
92	15881	Moshood Abiola Polytechnic Abeokuta	22160	16524	7274	5778
93	15904	Anambra State University of Science & Techno	21422	17787	6291	5778
94	15965	Kano University of Science & Technology Wud	19835	18456	6085	5778
95	16214	Kogi State Polytechnic Lokoja	24766	12767	8635	5778
96	16341	Adeniran Ogunsanya College of Education	21032	14313	8635	5778
97	16390	Crawford University Igbesa	21308	14286	8635	5778
98	16464	Veritas University	18691	15056	8635	5778
99	16482	Imo State Polytechnic Umuagwo Ohaji	18384	15149	8635	5778
100	16563	Lagos State Polytechnic	22094	16604	7820	5778

As shown in the figure, the indicators scores are indicated by the position of the respective universities on the world ranking. For example, University of Ibadan (UI) ranked number 1 in Nigeria and 1335 in the world ranking. The indicators ranking for UI based on the position on the world ranking is as follows; Presence 3446, Impact 1302, Openness 1612 and Excellence 1715. The same is applicable to all other 99 Nigerian universities in the ranking.

3. NORMALIZATION OF THE RANKING CRITERIA

The raw dataset from webometrics ranking as indicated Table . 2 contains ranking positions for the various criteria. In order to use this in our algorithm, the data needs to be prepared as acceptable input. This raw data was normalized to enable us present the data to the algorithm. This was to make room for easy integration into bias values which are non-negative value. The specified values for the four criteria range from 0.00 - 1.00 with the cumulative value equal 1.00. To achieve this, Linear Min-Max normalization technique was used. Applying this techniques to the top 100 Nigerian universities based on webometric ranking, the result is generation of ranking indicators ranging from 0.0000 - 1.0000.



The ranking listing of the 100 universities post normalization is as shown in Table 3 below:

Table 3: University Presence, Impact, Openness and Excellence Score

University	Presence Score	Impact Score	Openness Score	Excellence Score
University of Ibadan	0.2902	0.7680	0.6203	0.5831
Covenant University Ota	0.6017	0.6169	0.5147	0.3724
Obafemi Awolowo University	0.7837	0.3934	0.3970	0.3946
University of Lagos	0.4988	0.1635	0.4294	0.3967
University of Nigeria	0.3349	0.1719	0.7022	0.3565
University of Port Harcourt	0.1150	0.3095	0.4398	0.2891
University of Agriculture Abeokuta	0.3504	0.1842	0.4032	0.3200
University of Ilorin	0.1829	0.1579	0.4739	0.3400
Ahmadu Bello University	0.2392	0.1177	0.3911	0.3928
Federal University of Technology Owerri	0.0668	0.4087	0.2490	0.2591
Federal University of Technology Akure	0.2077	0.1010	0.3239	0.3455
Federal University of Technology Minna	0.0935	0.1278	0.3431	0.3200
University of Benin	0.1883	0.1298	0.3766	0.2852
University of Abuja	0.2214	0.2615	0.2589	0.1913
Afe Babalola University Ado Ekiti	0.3144	0.2763	0.5498	0.1731
Ladoke Akintola University of Technology	0.2501	0.0889	0.3920	0.2765
Bayero University Kano	0.0590	0.1138	0.3174	0.2891
University of Jos	0.2762	0.0979	0.2723	0.2539
University of Uyo	0.0445	0.0872	0.3423	0.3635
Nnamdi Azikiwe University	0.0972	0.0886	0.4427	0.2765
University of Calabar	0.1504	0.0772	0.4088	0.2958
Lagos State University	0.0625	0.0851	0.3095	0.2765
University of Maiduguri	0.0693	0.0809	0.2387	0.2852
Landmark University	0.2469	0.1491	0.2477	0.1731
(1) Michael Okpara University of Agriculture Umudike	0.0613	0.1573	0.2384	0.1913
Olabisi Onabanjo University (Ogun State University)	0.1039	0.0749	0.2306	0.2480
Babcock University	0.5299	0.1191	0.2461	0.1731
Rivers State University of Science & Technology	0.0615	0.0805	0.2874	0.2309
Federal University Oye Ekiti Ekiti State	0.2406	0.1194	0.2304	0.1731
African University of Science & Technology Abuja	0.2041	0.0704	0.1432	0.2414
Adekunle Ajasin University	0.0643	0.0773	0.2156	0.2231
(1) Ebonyi State University	0.0487	0.0726	0.2408	0.2356
American University of Nigeria	0.1694	0.0948	0.1926	0.1731
Federal University Dutsin Ma	0.0844	0.1001	0.2277	0.1731
Niger Delta University	0.0556	0.0682	0.2035	0.2309
Ekiti State University Ado Ekiti (University of Ado Ekiti)	0.0649	0.0815	0.2425	0.1913
Redeemer's University	0.0946	0.0849	0.3036	0.1731
Auchi Polytechnic	0.0848	0.1943	0.1158	0.1731
Osun State University	0.1105	0.0830	0.2880	0.1731
Usmanu Danfodiyo University	0.0820	0.0765	0.2050	0.1913
Enugu State University of Science & Technology	0.0695	0.0996	0.1857	0.1731
Federal University Ndufu Alike Ikwo FUNAI	0.0582	0.0861	0.2811	0.1731
Benue State University	0.0476	0.0722	0.1884	0.2034
Ambrose Alli University Ekpoma	0.0897	0.0711	0.1601	0.1913
Kwara State University	0.0743	0.0826	0.1917	0.1731
Abubakar Tafawa Balewa University	0.0451	0.0754	0.2264	0.1913
Fountain University Osogbo	0.2618	0.0630	0.2115	0.1731
Lagos Business School Pan Atlantic University	0.1772	0.0973	0.1158	0.1731
Federal University of Agriculture Makurdi	0.0536	0.0714	0.1600	0.1913



University	Presence Score	Impact Score	Openness Score	Excellence Score
Lead City University Ibadan	0.0526	0.0840	0.1717	0.1731
Abia State University Uturu	0.0395	0.0615	0.1842	0.2309
National Open University of Nigeria	0.0825	0.1076	0.1158	0.1731
Umaru Musa Yar'Adua University (Katsina State University)	0.0689	0.0722	0.1926	0.1731
Edo State Polytechnic Usen	0.0468	0.1363	0.1158	0.1731
Delta State University Nigeria	0.0490	0.0747	0.2235	0.1731
Polytechnic Ibadan	0.0575	0.0939	0.1266	0.1731
Federal University of Technology Yola	0.0479	0.0623	0.2235	0.1913
Ajayi Crowther University Oyo	0.0786	0.0729	0.1493	0.1731
Yaba College of Technology	0.0692	0.0975	0.1175	0.1731
Nigerian Defence Academy Kaduna	0.0570	0.0765	0.1591	0.1731
Federal University Dutse Jigawa State	0.1120	0.0659	0.1587	0.1731
Federal University of Petroleum Resources Effurun	0.0466	0.0694	0.1524	0.1913
Cross River State University of Science & Technology Calabar	0.0548	0.0656	0.1175	0.2231
Bowen University	0.0591	0.0752	0.1509	0.1731
Bingham University New Karu	0.0462	0.0813	0.1541	0.1731
Federal University Lokoja Kogi State	0.0908	0.0645	0.1674	0.1731
Joseph Ayo Babalola University	0.0564	0.0663	0.1359	0.1913
Elizade University Ilara Mokin	0.1334	0.0577	0.2014	0.1731
Pan African University Lagos	0.0485	0.0791	0.1434	0.1731
Air Force Institute of Technology	0.0417	0.0535	0.6281	0.1913
Nasarawa State University	0.0529	0.0667	0.1929	0.1731
Federal University Otuoke Bayelsa	0.0583	0.0693	0.1520	0.1731
Federal University Lafia Nasarawa State	0.0646	0.0610	0.1776	0.1731
Igbinedion University Okada	0.0467	0.0699	0.1562	0.1731
Akwa Ibom State University of Technology	0.0484	0.0623	0.2092	0.1731
Ondo State University of Science & Technology Okitipupa	0.0509	0.0691	0.1442	0.1731
Ibrahim Badamasi Babangida University Lapai	0.0467	0.0630	0.1986	0.1731
Tai Solarin University of Education	0.0750	0.0703	0.1227	0.1731
Imo State University Owerri	0.0474	0.0741	0.1158	0.1913
Benson Idahosa University	0.0593	0.0594	0.1708	0.1731
Federal University Wukari Taraba State	0.0493	0.0587	0.2165	0.1731
Al Hikmah University Ilorin	0.0474	0.0601	0.1938	0.1731
Federal Polytechnic Ilaro	0.0481	0.0642	0.1496	0.1731
Kogi State University	0.0686	0.0734	0.1158	0.1731
Nigerian Turkish Nile University Abuja	0.0476	0.0687	0.1289	0.1731
Petroleum Training Institute Effurun	0.0499	0.0799	0.1158	0.1731
Madonna University Nigeria	0.0484	0.0806	0.1158	0.1731
Kaduna Polytechnic	0.0508	0.0652	0.1299	0.1731
Paul University Awka Anambra State	0.0504	0.0775	0.1158	0.1731
Baze University Kuchigoro	0.0700	0.0566	0.1384	0.1731
Bauchi State University Gadau	0.0754	0.0531	0.1528	0.1731
Moshood Abiola Polytechnic Abeokuta	0.0451	0.0605	0.1375	0.1731
Anambra State University of Science & Technology Uli	0.0467	0.0562	0.1590	0.1731
Kano University of Science & Technology Wudil	0.0504	0.0542	0.1643	0.1731
Kogi State Polytechnic Lokoja	0.0404	0.0783	0.1158	0.1731
Adeniran Ogunsanya College of Education	0.0475	0.0699	0.1158	0.1731
Crawford University Igbesa	0.0469	0.0700	0.1158	0.1731
Veritas University	0.0535	0.0664	0.1158	0.1731
Imo State Polytechnic Umuagwo Ohaji	0.0544	0.0660	0.1158	0.1731
Lagos State Polytechnic	0.0453	0.0602	0.1279	0.1731



3.1 User Bias

Sample data was obtained by asking a population of undergraduates, High School students, graduates and guardians to rank Nigeria universities using webometrics standardized criteria. The technique used in the study was to allow individual award marks to the criteria blinded. Each individual has 100 marks and this marks has to be allocated to the four criteria with the cumulative value equals to 100. Depends on the preference and how important each individual consider the criteria in the choice of universities, the marks are allocated accordingly. A score of 0 means the criterion is of no significant value to the candidate and should not be considered in the ranking. Higher scores signify higher importance. Score 100 means that the individual considered all the other criteria as irrelevant and wants ranking to be determined by only single criterion. The sample form that was used in this study is as shown in figure 2 below:

anking Criteria For Universities				
1 Rate th	e following Criteria between 0 to 100 Total must be			
100				
Presence	15			
Impact	20			
Openness	35			
Excellence	30			
	Done			

Fig. 2: Sample Study form for Criteria Ratings

Individuals are not able to submit the sample data if the cumulative value is not equal to 100. Through this study, 870 individualized samples were obtained with ratings for the four criteria. The values of the criteria as scored by each candidate in our study were normalized to range from 0.00 to 1.00. Figure 2 shows a sample output of the webometrics criteria with the bias scores of the candidates in our study.



Table 4: Sample Criteria Scores by Candidates

Candidate	Presence	Impact	Openness	Excellence
Candidate 1	0.15	0.56	0.16	0.13
Candidate 2	0.17	0.45	0.17	0.21
Candidate 3	0.2	0.41	0.16	0.23
Candidate 4	0.14	0.43	0.23	0.2
Candidate 5	0.04	0.59	0.18	0.19
Candidate 6	0.18	0.49	0.2	0.13
Candidate 7	0.12	0.72	0.13	0.03
Candidate 8	0.2	0.55	0.18	0.07
Candidate 9	0.08	0.52	0.24	0.16
Candidate 10	0.13	0.31	0.14	0.42
Candidate 11	0.19	0.39	0.19	0.23
Candidate 12	0.1	0.51	0.2	0.19
Candidate 13	0.15	0.41	0.16	0.28
Candidate 14	0.14	0.73	0.11	0.02
Candidate 15	0.14	0.67	0.16	0.03
Candidate 16	0.14	0.61	0.14	0.11
Candidate 17	0.11	0.41	0.14	0.34
Candidate 18	0.12	0.52	0.1	0.26
Candidate 19	0.12	0.55	0.12	0.21
Candidate 20	0.19	0.54	0.23	0.04
Candidate 21	0.15	0.44	0.15	0.26
Candidate 22	0.12	0.48	0.18	0.22
Candidate 23	0.18	0.37	0.12	0.33
Candidate 24	0.12	0.53	0.11	0.24
Candidate 25	0.16	0.56	0.14	0.14
Candidate 26	0.15	0.6	0.25	0
Candidate 27	0.18	0.48	0.14	0.2
Candidate 28	0.13	0.53	0.17	0.17
Candidate 29	0.15	0.59	0.2	0.06
Candidate 30	0.16	0.61	0.18	0.05
Candidate 31	0.11	0.29	0.19	0.41
Candidate 32	0.23	0.39	0.17	0.21
Candidate 33	0.12	0.47	0.11	0.3
Candidate 34	0.15	0.35	0.07	0.43
Candidate 35	0.15	0.52	0.19	0.14
Candidate 36	0.13	0.62	0.14	0.11
Candidate 37	0.12	0.41	0.16	0.31
Candidate 38	0.17	0.52	0.12	0.19
Candidate 39	0.16	0.45	0.14	0.25

The values are compared, and weights are assigned to each, according to their order of importance. Weights are assigned in decreasing order of importance, with higher weights assigned to the more important criteria. These weighted normalized values of the standards serve as the input user bias in the algorithm. If the default values are used in the ranking, then the user bias has no effect on the ranking.



3.2 Ranking of Nigerian Universities Using the Enhanced Recursive Ranking Algorithm

A total of 870 individually-biased samples were collected. For each sample, the user bias scores were computed for each criterion. With the user bias values considered in the ranking, the universities were ranked using the proposed Enhanced Recursive Ranking Algorithm as outlined in section 4.3. Thus, the cardinal and ordinal rankings were generated for each sample. This way, a total of 870 ranking comparisons for the 100 universities were carried out. An extract of the outcome of bias ranking scores is shown in table 4.6. We outlined the results obtained in the next subsection.

UNIVERSITY	CANDIDATE 1	CANDIDATE 2	CANDIDATE 3	CANDIDATE 4	CANDIDATE 5	CANDIDATE 6	CANDIDATE 7	CANDIDATE 8
UNIVERSITY OF IBADAN	0.648661	0.622836	0.606281	0.630157	0.687171	0.628419	0.685916	0.632911
COVENANT UNIVERSITY OTA	0.566483	0.545597	0.541273	0.542366	0.551441	0.561939	0.594455	0.578349
OBAFEMI AWOLOWO UNIVERSITY	0.452677	0.460615	0.472312	0.44911	0.409888	0.46453	0.44074	0.472192
UNIVERSITY OF LAGOS	0.286655	0.314676	0.32674	0.318239	0.269082	0.30735	0.245299	0.294746
UNIVERSITY OF NIGERIA	0.305196	0.328527	0.331806	0.353609	0.308948	0.331298	0.265937	0.312876
UNIVERSITY OF PORT HARCOURT	0.298521	0.294302	0.286756	0.308159	0.321298	0.297898	0.302487	0.292626
UNIVERSITY OF AGRICULTURE ABEOKUTA	0.261824	0.278202	0.283714	0.284998	0.25607	0.27557	0.236688	0.266366
UNIVERSITY OF ILORIN	0.235883	0.254111	0.255343	0.2705	0.250379	0.249273	0.207443	0.232527
AHMADU BELLO UNIVERSITY	0.215432	0.242604	0.249017	0.252612	0.224041	0.230013	0.176075	0.210469
FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI	0.312415	0.292012	0.28036	0.294183	0.337854	0.29577	0.342423	0.301102
FEDERAL UNIVERSITY OF TECHNOLOGY AKURE	0.184454	0.208377	0.214239	0.216105	0.191845	0.196571	0.150116	0.179577
FEDERAL UNIVERSITY OF TECHNOLOGY MINNA	0.182089	0.198932	0.199594	0.210957	0.2017	0.189672	0.157439	0.173148
UNIVERSITY OF BENIN	0.198265	0.214335	0.21673	0.225834	0.20609	0.209892	0.173566	0.196802
UNIVERSITY OF ABUJA	0.245943	0.239499	0.236918	0.241248	0.24609	0.244636	0.254244	0.248098
AFE BABALOLA UNIVERSITY ADO EKITI	0.312359	0.3076	0.303944	0.323899	0.307446	0.324442	0.313331	0.325926
LADOKE AKINTOLA UNIVERSITY OF TECHNOLOGY	0.185964	0.207227	0.212784	0.218701	0.18555	0.202924	0.153275	0.18883
BAYERO UNIVERSITY KANO	0.160945	0.175909	0.175735	0.188016	0.181563	0.167445	0.138951	0.151759
UNIVERSITY OF JOS	0.172829	0.190619	0.197344	0.194174	0.166064	0.185154	0.146648	0.175872
UNIVERSITY OF UYO	0.15753	0.181331	0.183025	0.195155	0.183907	0.166453	0.123528	0.143919
NNAMDI AZIKIWE UNIVERSITY	0.170973	0.189718	0.190193	0.208827	0.188383	0.185395	0.141302	0.167211
UNIVERSITY OF CALABAR	0.169654	0.191922	0.195174	0.207436	0.18135	0.185114	0.13565	0.16683
LAGOS STATE UNIVERSITY	0.142496	0.1596	0.160506	0.171828	0.160954	0.150794	0.117302	0.13437

Table 5: Extract of Universities Ranking with User Bias





Fig 3: Stacked Line Chart of Selected extract of Universities Ranking with User Bias

3.3. Comparison of the Ranking Results

Out of the 870 ranking outcomes, 156 were the same as that of Webometric while 714 ranking were different. Three Universities University of Ibadan (UI), Covenant University (CU) and Obafemi Awolowo University (OAU) maintained the top 3 positions respectively in 710 bias rankings. A total of 610 unique outcomes were generated from the possible 870 outcomes. The global Mean Ordinal Ranking for the 870 sample candidates for the top 10 universities is UI > CU > OAU > UNN > FUTO > UNILAG > UNIPORT > FUNAAB > UNILORIN>ABU compared to Webometric ranking of the top 10 universities UI > CU > OAU > UNI > OAU > UNILAG > UNIPORT > FUNAAB > UNIPORT > FUNAAB > UNILORIN > ABU > FUTO as shown in table 6. The global Mean Cardinal ranking for the 870 sample candidates for the top 10 universities in our sample data is shown in the table below for both webometrics and bias ranking using Enhanced Recursive Ranking Algorithm (ERRA).

	Traditional Ranking (Webometrics)	Ranking with ERRA
Cardinal Ranking	{0.56},{0.53},{0.49},{0.39},{0.37},{0 .32},{0.31},{0.29},{0.28},{0.28}	{0.64},{0.55},{0.45},{0.31},{0.30},{0.30},{0.30},{0. 29},{0.26},{0.24}
Ordinal Ranking	UI > CU > OAU > UNILAG > UNN > UNIPORT > FUNAAB > UNILORIN > ABU > FUTO	UI > CU > OAU > UNN > FUTO > UNILAG > UNIPORT > FUNAAB > UNILORIN>ABU



University	Webometrics Ranking	Enhanced Recursive Rank
UI	1	1
CU	2	2
OAU	3	3
UNILAG	4	6
UNN	5	4
UNIPORT	6	7
FUNAAB	7	8
UNILORIN	8	9
ABU	9	10
FUTO	10	5

Table 7: Comparison of the ranking results (Webometrics versus ERRA)



Figure 4: Candidate Average Score and Webometrics Score





Figure 5: Webometrics Normalized Scores

4.3.2. Statistical Analysis of the Ranking

The bias score for Excellence and Impact followed normal probability distribution while that of presence and openness follow random distribution. The variance for each of the criteria (Presence, Openness, Impact and Excellence) were calculated to determine the variation in how individual candidates value each of the criteria. The outcome of the variable is shown in figure 5. There's low variance value for presence and openness which shows that our sample population has low variability in those two criteria. The outcome of each sample is close to the average of the total samples, as such the candidates are somewhat in agreement as regards the importance of the criteria in determining universities ranking. On the other hand, impact and excellence show high variability which means that the sample population has wider range of agreement as regards these two criteria. While some will consider the two criteria as highly important, many also believe they are much less important.



and low in others.



In all, the total variance of the four criteria is from 0.0018 to 0.011, this shows a low variability across board. As a result, the criteria and generally acceptable to the sample population as necessary consideration for effective universities ranking outcome. We also calculated the variance for each individual score per universities in our study. Figure 6 shows the variance in individual scores for the 100 universities in our consideration. The figure shows high variance in some





Figure 7: Variance of Individual Score per University.

Overall, there is high variability in the individually bias scores for each of the universities. This shows also that user bias should be a key component when designing searching and ranking algorithm. What is good for A may not be good for B and when it is good for both, then the degree of acceptability has to be taken into consideration. The Variance of the distribution for the top 10 universities from the Webometric listing is as follows: 0.0004951, 0.0006231, 0.0002419, 0.0005362, 0.0006553, 0.0001131, 0.0001976, 0.0003805, 0.000692 and 0.0002866. There is low variability among the rankings for the top 10 universities.





Figure 8: Correlation between Bias Score and Webometric Score

Finally, we used the Pearson Correlation Coefficient to determine the correlation between the actual Webometrics ranking and the individually biased ranking. The results show that there is strong correlation between the two outcomes. The graph of the correlation is as shown in figure 8

4. DISCUSSION OF RESULTS

The results obtained from the experimental study of our mode demonstrated the effectiveness of the ERRA. By analyzing the influence of user bias on ranking, the search results showed that user bias should not be ignored to enhance personalized experience while searching. The strong correlation between the original ranking and the personalized ranking already suggests a strong influence. Suppose two users A and B input the same query "Nigerian Universities", but different values for the search criteria as follows: user A - Presence(20), Openness(20), Impact(50), Excellence(10); user B – Presence(15), Openness(40), Impact(20), Excellence(25). We apply the ERRA to ranking the search results. It can be seen that obviously for user A, Impact is the most important criterion, while Excellence is the least important. For user B, Openness should be given the biggest consideration. The search results for each user will obviously be different. This example clearly illustrates that our algorithm takes user bias into account in ranking results. It should be noted that since bias varies from one user to the other, it means searches by different users using the ERRA are likely to return different ranking results.

5. CONCLUDING REMARKS

This paper presents the results of the experimental study of our proposed Enhanced Recursive Ranking Algorithm. The algorithm was applied to the ranking of Nigerian universities with the consideration of user-specified criteria. The results show that user bias has strong influence on the final ranking. Still, to our knowledge, link analysis procedures largely ignore any hierarchical structure accompanying an information or social network. We introduced ERRA, a link analysis technique for ranking individuals that exploits hierarchical structure. The foundational basis for ERRA is the peer-review principle, which implies that the relative ranking between two individuals be determined by their local ranks in the smallest community to which they both belong. This principle, together with a hypothesis due to Bonacich, leads to a recursive algorithm which is scalable, parallelizable, and easily updateable.



For a large-scale network such as the Web, we anticipate that ERRA will yield substantial computational gains over standard ranking methods (e.g., calculating Page-Ranks via the power method). Moreover, it appears more resistant to link-spamming than other popular ranking algorithms on contrived examples, although it remains to verify this

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