Digital Library Research in India during 1989-2018: A Scientometric Analysis Based on Scopus Database

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ABSTRACT: *The present study aims to analyse the growth of digital library publication in India. Scientometrics is one of the most important measures for the assessment of scientific productions. The study covers a total of 1068 research papers indexed by Scopus database from the marked period of study and studies examined and analysed on the basis of the distribution of publication, identify the authorship pattern, annual growth rate, the degree of collaborations and the most productive authors. The highest 108 (10.11%) of research papers were published in the year 2016 and out of 1068 publications, the maximum 398 of research papers were published by two authors. The maximum (300) annual growth rate was recorded in the year 1997 and overall degree of collaboration is 0.81. The most prolific author on the digital library was Urs, S.R. with 13 publications.*

Keywords: Scientometrics, Digital Library, Authorship Pattern, Degree of Collaboration, Relative Growth Rate (RGR) and Doubling Time (Dt)

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1. Introduction

Scientometrics is the study of the quantitative aspects of the process of science as a communication system. In recent years it has come to play a major role in the measurement and evaluation of research performance. Scientometric may prove to be one of the best tools available for science evaluators, policy makers, science administrators and librarians.

Digital Libraries are now emerging as a crucial component of worldwide information infrastructure, adopting the update information and communication technology (ICT). In India, a number of institutions are on the way to the process of setting up digital libraries and many researchers and practitioners are conducting research on digital libraries. (DLF, USA - http://www.dlf.org), "Digital libraries are organizations that provide the resources, including the specialized staff, to select, structure, offer intellectual access to, interpret, distribute, preserve the integrity of, and ensure the persistence over time of collections of digital works so that they are readily and economically available for use by a defined community or set of communities". Total numbers of 1068

research papers were found in Scopus database during the period of study 1989-2018 (as on 13 July, 2018) in which majority of the papers (1053) are in closed access and only 15 research papers were found as open access.

2. Literature Review

Amsaveni and Hari (2018) conducted a scientometric analysis of environmental management research output during (1989–2014) in which a total 61877 records were found from the Web of Knowledge, includes, SSCI, A&HCI, SCI databases from the marked period of study. the analysis examines the different pattern of scientometrics such as the distribution of publication year wise, doubling time, most popular journal name, most prolific authors, and found that the maximum number of records were published in the year 2014, the highest 99 doubling time was recorded in 2001. The most productive author name was Huang GH with 213 records and got the first rank, followed by Chang NB with 83 records, and secured the second position, in the Journal of Environmental Management, the highest 930 articles were published [1].

Velmurugan and Radhakrishnan (2017) conducted a study on scientometric analysis of the scholastic publications by the Indian scientists on social media and found that Jawaharlal Nehru University (JNU) has contributed maximum number of publications and got the rank first, among top 10 nations, the USA was most contributed country with 40 research papers (16.1%) having 812 citations followed by UK (7.3%) with 27.44 average citations per paper [2].

Yeshawant and Ravi (2016) conducted a scientometric dimensions of blood cancer research from the marked period (2004-2013), in which a total 1936 record has been found and after analysis of different scientometric pattern, it is found that the highest number of research papers were published in the year 2012 i.e. 324, followed by 308 publications in the year 2013. In the year wise growth of publication of India, out of a total 1731 publications, 286 (5.49%) of publications were published in the year 2012, followed by 255 (3.93%) of records were published in the year 2013. 173 publications per year contributed to the subject of Blood Cancer from (2004-2013) [3].

Gupta et al. (2016) carried out a scientometrics study on lung cancer in India during 2005-2014 on the basis of SCOPUS database. The study examined various scientometric pattern like most productive countries, geographical distribution of publication in India, most productive authors, most productive journals in India, and found that the highest 51299 papers were contributed by the United States, the most active authors were N. Singh and A K Saxena with 37 of contribution each, followed by C S Pramash with 33 papers contributions [4].

Jeyshankar and Babu (2013) carried out a scientometric analysis of leukemia research output from the marked period (1960-2011) in which a total of 2120 papers were published in the field of Leukemia research. The data was collected through the SCOPUS database. The study examines and found that the highest 40.80% of papers were published during the period (2007-2011) and the maximum 79.76% of publications were contributed by multiple authors. The maximum 0.96 degree of collaboration was recorded from the marked period (1987-1991), and in the co-authorship index (CAI), the maximum 389.71 recorded by the single author during (1960-1971). The maximum 135 (6.37%) of publications were published in Indian Journal of Cancer [5].

3. Scope

The present study is limited to scintometrics analysis of research output on digital library during the period 1989-2018. The study is further limited to analysis of papers published from India during the period and listed in Scopus database.

Objectives of the study

1. To analysis the year wise distribution of the publication
2. To identify the types of documents published in the digital library
3. To examine the annual growth rate (AGR) and compound annual growth rate of publications (CAGR) of articles on digital library
4. To analysis the relative growth rate and doubling time of publication on digital library
5. To examine the authorship pattern and degree of collaboration
6. To analysis the most productive authors

4. Methodology

An International online bibliographic database Scopus has been taken up for the study. Scopus is a bibliographic database which is containing abstracts and citations for academic journal articles. It is owned by Elsevier and is available online by subscription. Searches in Scopus also associated with searches of patent databases. The following search string (digital library) has been adopted for the extracting data of the digital library. There are 1068 records available in Scopus database on 13 July 2018. These records along with full bibliographical details such as Title, Authors, Year, Affiliation, Document Type, etc. have been extracted from the Scopus database. The extracted data from the database further processed and analysed by using Microsoft Excel. The extracted data has been tested by the scientometrics tools and techniques to ascertain the fulfilment of objectives.

5. Data Analysis

Year	No. of Publications	Percentage of Publication	Cumulative
1989	1	0.09	0.09
1993	2	0.19	0.28
1994	1	0.09	0.37
1996	1	0.09	0.46
1997	4	0.37	0.83
1998	2	0.19	1.02
1999	3	0.28	1.3
2000	5	0.47	1.77
2001	8	0.75	2.52
2002	15	1.40	3.92
2003	22	2.06	5.97
2004	78	7.30	13.27
2005	28	2.62	15.89
2006	36	3.37	19.27
2007	43	4.03	23.28
2008	48	4.49	27.77
2009	42	3.93	31.7
2010	50	4.68	36.38
2011	55	5.15	41.53
2012	69	6.46	47.99
2013	103	9.64	57.63
2014	87	8.15	65.78
2015	105	9.83	75.61
2016	108	10.11	85.72
2017	99	9.27	94.99
2018	53	4.96	100

Table 1. Year Wise Distribution of Articles

5.1 Year Wise Distribution of Publication

Table 1 shows India's year wise distribution of digital library publications during the period (1989-2018). From the marked period of study 108 (10.11%) of total research papers were published in the year 2016, followed by 105, constituting 9.83% of publications were published in 2015 and 103 (9.64%) of contribution were published in the year 2013. On the observation of table 1, it is clearly shown that fluctuations are there.

5.2 Annual Growth Rate of Articles

Table 2 has been noticed the Annual Growth Rate (AGR) of digital library publication from the marked period of study. On the

Year	No. of Publication	AGR
1989	1	0
1993	2	100
1994	1	-50
1996	1	0
1997	4	300
1998	2	-50
1999	3	50
2000	5	66.667
2001	8	60
2002	15	87.5
2003	22	46.667
2004	78	254.545
2005	28	-64.103
2006	36	28.571
2007	43	19.444
2008	48	11.628
2009	42	-12.5
2010	50	19.048
2011	55	10
2012	69	25.455
2013	103	49.275
2014	87	-15.534
2015	105	20.689
2016	108	2.857
2017	99	-8.333
2018	53	-46.465

Table 2. Annual Growth Rate of Articles

observation of table 2, it has been clearly shown that in the year 1997, the maximum (300) AGR was recorded, followed by (254.545) AGR in the year 2004. In the year 1989 and 1996, the annual growth rate is null. A total AGR was displayed in the below table 2. The annual growth rate (AGR) is calculated on the formula given by Kumar and Kaliyaperumal in 2015 [6] and mention below:

$$AGR = \frac{EndValue - FirstValue}{FirstValue} \text{ X } 100$$

5.3 Compound Annual Growth Rate of Articles

Table 3 present the Compound Annual Growth Rate (CAGR) of publications. The CAGR is measured by taking the n^{th} root of the overall %age growth rate, where n is the number of years in the period being considered [7]. The yearly output of the particular title digital library is increasing year after year but the CAGR is in fluctuation trend. The whole description was shown in below table 3.

The compound annual growth rate was calculated by the following formula available on https://www.investopedia.com/terms/c/cagr.asp)

$$CAGR = [(EndingValue - BeginingValue)^{1/n} - 1]$$

5.4 Relative Growth Rate and Doubling Time of Publication

The table 4 and Figure 1, it clearly shows the Relative Growth Rate (RGR) and doubling time (Dt.) of digital library publication during the period of study. The RGR counted the increased number of articles/pages per unit of time. The year wise growth rate of whole contributions has been measured on the basis of RGR and Dt model, which is propounded by Mahapatra in 1985 [8]. RGR is calculated to analyse the increase in the number of publications on time and the Dt is directly related to RGR.

The mean Relative Growth Rate over the specific period of the interval can be calculated from the following equation:

$$RGR = \frac{W2 - W1}{T2 - T1}$$

Where,

RGR = Growth Rate over the specific period of the interval,

W1 = Log_e (natural log of the initial number of contributions)

W2 = Log_e (natural log of the final number of contributions)

T1 = The unit of initial time

T2 = The unit of final time

Doubling Time

From the calculation, it is defined that there is a direct equivalence has existed between the Relative Growth Rate (RGR) and Doubling time (Dt). If the number of contributions of a subject doubles, within a given period i.e. (1989-2018), then the difference between the logarithm of the numbers at the starting and at the end of the period must be the logarithms of the number 2. If the natural logarithm is used this difference has a value of 0.693. The overall distribution of publication of Relative Growth Rate and Doubling Time has been shown on below table 4. Thus the corresponding doubling time for each specific period of interval and for both articles and pages can be calculated by the following formula:

$$Doubling\ Time\ (Dt) = \frac{0.693}{R}$$

Year	No. of Publication	Cumulative Frequency	CAGR	CAGR (%)
1989	1	1	0.000	0
1993	2	3	0.189	18.92
1994	1	4	-0.129	-12.94
1996	1	5	0.000	0
1997	4	9	0.189	18.92
1998	2	11	-0.074	7.41
1999	3	14	0.041	4.14
2000	5	19	0.048	4.75
2001	8	27	0.040	3.99
2002	15	42	0.050	4.95
2003	22	64	0.028	2.77
2004	78	142	0.088	8.8
2005	28	170	-0.062	-6.2
2006	36	206	0.015	1.49
2007	43	249	0.010	0.99
2008	48	297	0.006	0.58
2009	42	339	-0.007	-0.67
2010	50	389	0.008	0.83
2011	55	444	0.004	0.43
2012	69	513	0.010	0.99
2013	103	616	0.017	1.68
2014	87	703	-0.007	-0.67
2015	105	808	0.007	0.73
2016	108	916	0.001	0.1
2017	99	1015	-0.003	-0.31
2018	53	1068	-0.021	-0.21

Table 3. Compound Annual Growth Rate of Articles

5.5 Authorship Pattern

Table 5 and figure 2 highlights that authorship pattern of digital library publication during the period of study. Out of total 1068 publications, the highest 398 research papers were contributed by two authors, followed by three authors with 231 publications. Single authors have published 204 research papers, followed by four authors with 131 contributions, five authors were contributed 90 research papers and 14 research papers were contributed by more than five authors.

Year	No. of publication	Cumulative Sum	W1	W2	RGR	Dt
1989	1	1	0	0	0	0
1993	2	3	0	1.099	1.099	0.631
1994	1	4	1.099	1.386	0.287	2.415
1996	1	5	1.386	1.609	0.223	3.108
1997	4	9	1.609	2.197	0.588	1.179
1998	2	11	2.197	2.398	0.201	3.448
1999	3	14	2.398	2.639	0.241	2.876
2000	5	19	2.639	2.944	0.305	2.272
2001	8	27	2.944	3.296	0.352	1.969
2002	15	42	3.296	3.738	0.442	1.568
2003	22	64	3.738	4.159	0.421	1.646
2004	78	142	4.159	4.956	0.797	0.869
2005	28	170	4.956	5.136	0.18	3.85
2006	36	206	5.136	5.328	0.192	3.609
2007	43	249	5.328	5.517	0.189	3.667
2008	48	297	5.517	5.694	0.177	3.915
2009	42	339	5.694	5.826	0.132	5.25
2010	50	389	5.826	5.964	0.138	5.022
2011	55	444	5.964	6.096	0.132	5.25
2012	69	513	6.096	6.24	0.144	4.813
2013	103	616	6.24	6.423	0.183	3.787
2014	87	703	6.423	6.555	0.132	5.25
2015	105	808	6.555	6.695	0.14	4.95
2016	108	916	6.695	6.817	0.122	5.68
2017	99	1015	6.817	6.923	0.106	6.538
2018	53	1068	6.923	6.974	0.051	13.588

Table 4. Relative Growth Rate and Doubling Time of Publication

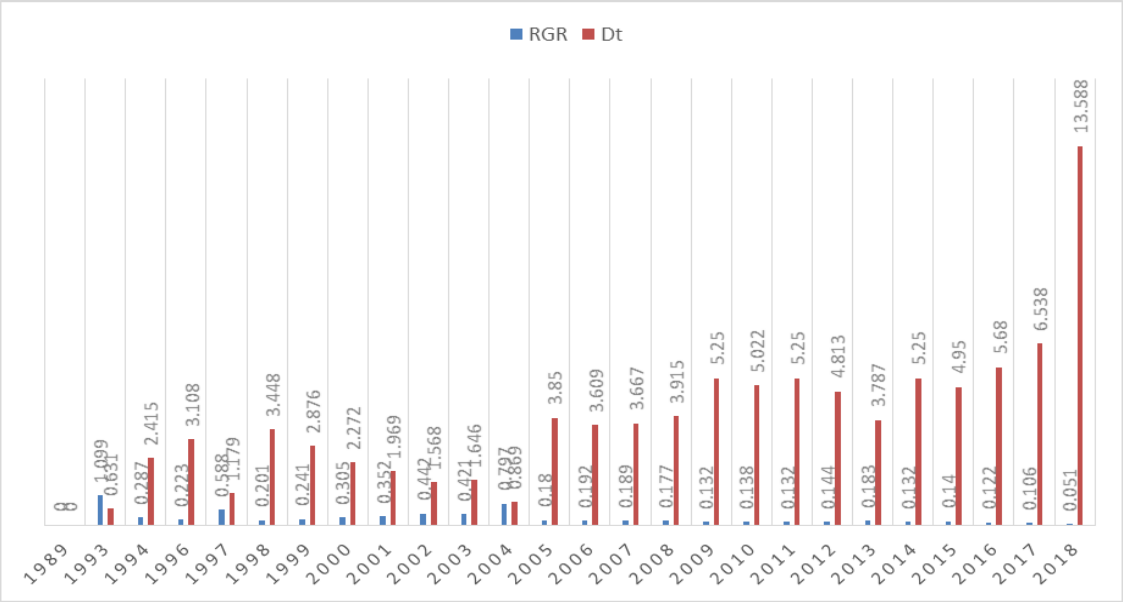

Figure 1. Relative Growth Rate and Doubling Time of Publication

Single Author	Two Author	Three Authors	Four Authors	Five Authors	More than Five Authors	Total
204	398	231	131	90	14	1068

Table 5. Authorship Pattern

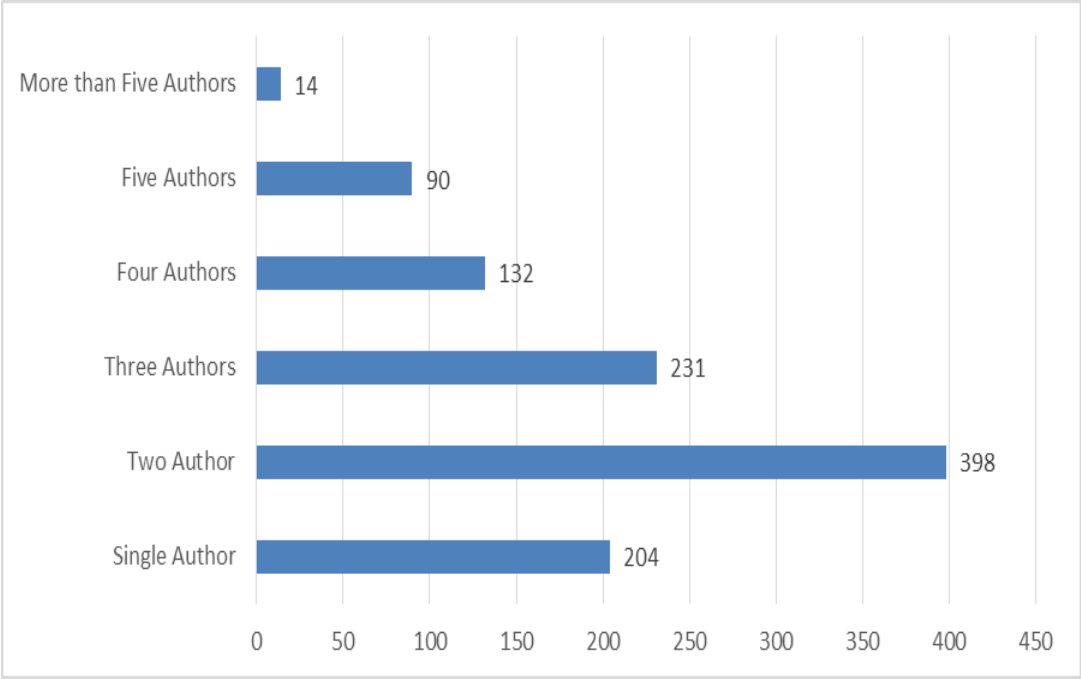

Figure 2. Authorship Pattern

5.6 Degree of Collaboration

Table 6 shows that the degree of author's collaboration from the marked period (1989-2018). Out of total 1068 publications, 864 contributions published by multiple authors and 204 research papers were contributed by a single author. The degree of collaboration in digital library publication is 0.81. This comes out with clearly the moderate prevalence has been given for collaborative research. The formula suggested by Subramanianm (1983) is used to measure the Degree of Collaboration. It is expressed as:

$$DC = \frac{Nm}{Nm + Ns}$$

Where, "DC is the degree of collaboration, *Nm* is the multiple-authored articles and *Ns* is the number of the single-authored articles" [9].

Year	**Single Authored Publications (*Ns*)**	**Multiple Authored Publications (*Nm*)**	***Nm* + *Ns***	**Degree of Collaboration *DC* = *Nm*/(*Nm* + *Ns*)**
1989-2018	204	864	1068	0.81

Table 6. Degree of Collaboration

5.7 Productive Authors

Table 7 indicates the most productive authors of 'digital library' publication from (1989-2018). The most prolific authors were Urs. S.R with the maximum of 13 publications, followed by Arora, J. with 12 contributions and Ghosh, M. got the third place with 10 publications. The table shows the most productive authors who were contributed more than 6 research papers on 'digital library' topic.

Authors Name Total	**Numbers of Publications**
Urs, S.R.	13
Arora, J.	12
Ghosh, M.	10
Goswami, B.	7
Goyal, P.	7
Jawahar, C.V.	7
Mukherjee, A.	7
Chanda, B.	6
Chaudhuri, B.B.	6
Chowdhury, S.P.	6
Jeevan, V.K.J.	6
Krishnamurthy, M.	6
Varma, V.	6

Table 7. Most Productive Authors

5.8 Types of Documents

Table 8 and figure 3 depicts that the different types of document contributed in the field of digital library from the marked period of study, out of which total 1068 publications, the highest 482 (45.13%) research papers were published in form of conference proceedings, followed by journal articles (454) constituting 42.51% of publications and book chapter (58) constituting 5.43% and review papers (55) out of total publications. The least preferred type of documents in digital library research is letters, notes and editorials.

Documents	Total No. of Publication	Percentage
Conference Paper	482	45.13
Article	454	42.51
Book Chapter	58	5.43
Review	55	5.15
Book	8	0.75
Article in Press	5	0.47
Editorial	3	0.28
Note	2	0.19
Letter	1	0.09
Total	**1068**	**100**

Table 8. Types of Documents

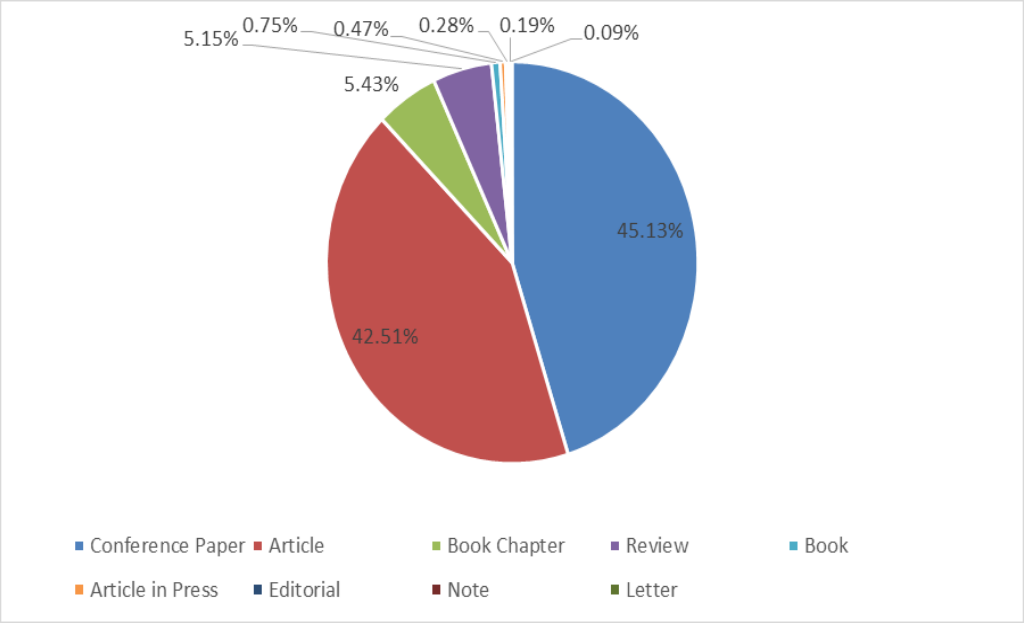

Figure 3. Types of Documents

5.9 Keywords in the Publications

Table 9 shows the keyword of the documents contributed in the field of digital library from the marked period of study. On the observation, it clear that the most preferred keyword is 'Digital Libraries' which used in 472 publications, followed by 'Information Retrieval' with 88 used and 'Libraries' with 84 papers publications as keywords. The other important keywords are India, digital libraries, information services and database systems.

Keyword	No. of Publications
Digital Libraries	472
Information Retrieval	88
Libraries	84
India	78
Digital LibraryA	76
Information Services	63
Database Systems	53
Digital Storage	52
Search Engines	52
Information Technology	48

Table 9. Keywords used in Publications

5.10 Affiliation Name

Table 10 shows the affiliation name of the institutions from where papers on digital library were published and it is depicted that the highest 33 publication on 'digital library' was published by Anna University, followed by 33 publications contributed by Indian Institute of Technology, Kharagpur, and 28 publications were contributed by University of Mysore.

Affiliation Name	No. of Publications
Anna University	33
Indian Institute of Technology, Kharagpur	32
University of Mysore	28
University of Delhi	25
Indian Statistical Institute, Kolkata	22
Indian Institute of Technology, Bombay	21
Indian Institute of Science, Bangalore	19
Indian Institute of Technology Delhi	18
Vellore Institute of Technology	16
Indian Statistical Institute Bangalore	15

Table 10. Affiliation Name

6. Discussion and Conclusion

This study would help in understanding the present conditions and frame an action plan to concentrate on digital library improvement in India. Utilize and user's investigations of digital libraries in India are inadequate. This zone is likewise of foremost significance for surveying the current digital libraries and making profoundly user-centric digital libraries in India

The present study shows that the maximum numbers of research papers were published in the year 2016 and the highest numbers of papers were contributed by two authors followed by three authors. This brings out clearly the moderate prevalence has been given for collaborative research and the average of the whole degree of collaboration is 0.81. The highest annual growth rate was recorded in 1997 i.e. 300. The yearly output of the particular title digital library is rising year after year but the CAGR is in fluctuation trend. The maximum 482 (45.13%) of documents were published in the form conference proceedings and in the field of computer science, while the keyword is 'Digital Libraries' comes in 472 publications during the period of study.

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