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A Study of Linear Scatter of Articles and Growth Rate of Informatics in Information Storage and Retrieval Literature

Abstract

The article literature on Information Storage and Retrieval in library and information science having application of Informatics is studied for the period of twenty years from 1981 to 2000. Ranking of journals and their contributions are described. The paper examines the linear scatter of articles, application of Bradford's law, nature of bibliography and the core journals in the area. The linear regression analysis on the data implies the extent of literature coverage in the bibliography of the subject area. The study also describes the growth rate of journals and articles with the analysis of most productive journals.

Keywords: Linear Scatter of articles, Grow rate of articles, Informatics, Information storage and retrieval articles.

Introduction

Informatics has the wider application of computer and Information Communication Technology (ICT) in the area of information handling in Library and Information Science (LIS). The study specifically includes informatics in Information Storage and Retrieval (ISAR) literature. The study covers topics such as Online Information Search, Library Automation, Digital Libraries, Virtual Libraries, Information Storage Techniques and Systems, Information Retrieval Techniques and Systems, Automatic Indexing and Abstracting, Data Formats, Data Mining, Experts Systems, Data Sharing etc.

The main objective of this study implies an informetric study on computerized information storage and retrieval compiled literature. The analysis of collected data

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traces the Linear Articles Scatter and Growth rate patterns in the field. The data has been collected from the *Library and Information Science Abstracts* (LISA) for the period of twenty years from 1981 to 2000. This period has witnessed sharp growth and development in terms of techniques and system in information storage and retrieval using informatics in LIS. The study mainly aims at: (i) Application of Bradford law of Scatter in ISAR, (ii) Identification of core journals in the subject, (iii) Comparison and description of the observed number of articles to expected number of articles on the basis of regression analysis, (iv) Comparison of the observed data to estimated data according to Brooks formulation, (v) Analysis of the geographical dispersion of the highly ranking journals, (vi) Determining the Growth rate of journals in ISAR and (vii) Measuring the Growth rate of Articles in ISAR.

Review of Literature

There is a lot of literature on Bradford's Law. Many studies, applications and modifications have been practiced on this law within the past decades. M. Feicheng and C. Rui (1999) used the frequency rank analysis of Bradford's law in a research on mechanism and model of scattering distribution of scientific information. R.K. Ravichandra Rao (1998) examined the applicability of what Bradford in his book on 'Documentation' derived the law of scattering, based on algebraic explanation with the supposition that n1 = n2 = n. M.H. Heine(1998) noticed the different ranking conventions which exists in the relationship between 'journal productivities' and 'journal ranking by productivity' of Bradford's distributions. In another study carried out by W. Chongde and W Zhe(1998) it was decided to conduct a goodness of fit test for 2 models for Bradford's law given by Egghe and Smolkov. They conclude that Smolkov's model is of comparatively higher accuracy. Wagner (1997) investigates time dependencies of Bradford distributions for 19th century mathematics and for 20th century logic. Y.K. Chung (1994) applies Bradford's law of scattering in a diverse subject. This law was applied to the analysis of the authors of source documents on the subject of classification schemes, published in core periodicals over the period 1981-1990A. Bookstein (1994) states that Bradford's law, perhaps the most well known of the informetric regularities, analyses the scattering of articles in a single discipline over journals. Meanwhile, he believes that journals are multi-disciplinary entities.

The growth of science has been a subject of investigation for the last 60 to 70 years. Cole and Eales (1917) studied the historical development of comparative anatomy over three centuries, covering the period since 1550, with desegregation of the data by country and topical sub-area within the field. These scholars utilized published literature for constructing the quantitative profile and indicators of a scientific specialty. The mathematical concepts of growth have become widely known and utilized by different scholars such as Crane(1972), Sullivan et al. (1977), Tague et al. (1981), Braun et al. (1977), May (1966), Menard (1971) and many others whereas growth models such as Exponential Growth Model, Logistic Growth Model, Gompertz Model, etc. have been developed.

Description of Data

The search in LISA on the topics in ISAR resulted in 3725 records and the articles scattered to 381 journals. Looking more closely, it is found that the largest number of articles contributed by single journal title was 268. On the other hand, there were 130 journals contributing only one article each. Ranks were assigned to the journals so that the journal contributing the most articles was ranked number one; the journal with the next greatest number of articles was ranked number two; and so on as shown in Table 1. Each line in the Table represents specific journal(s). The second column represents the number of articles contributed by the journal(s). Thus, looking only the first two columns, it is observed that the first journal contributed 268 articles while the next journal (rank2) contributed 261. Scanning down the table, it is observed that the number of articles contributed by each successive journal drops very quickly. On reaching the bottom of the table, the journal ranked forty five (Fifty journals) contributed two articles each. Also the journals ranked forty six (130 journals) contributed only one article each. The third column indicates the number of journals against each rank. Cumulative number of journals against the rank lists the cumulative articles in each line in the fourth column.

A cumulative article, which reports a running total of the articles, retrieved calculated in the fifth column. In the first row, the first ranked journal published 268 articles. The second row indicates the total number of articles 529, from the first two journals (268 from the first plus 261 from the second). Similarly the first three journals, contributed a total of 784 articles and so on as shown in the fifth column. The cumulative percentage of articles is given in the sixth column.

Scanning down the sixth column it is now observed that the first four journal titles could supply over one quarter (25 percent) of all the articles. Similarly twenty journals would suffice to supply over half (54 percent) of articles. This approach can be used by libraries or information centers to identify important journal titles or to select items for weeding.

Linear Articles Scatter

On the articles scatter Garfield (1980) believes that a physical analogy of the situation described by Bradford would be a comet, with the nucleus representing the core journals of a field and the tail represents additional journals that sometimes publish material relevant to the field. Bradford's law was expressed both as a verbal and as a graphical formulation. These expressions prompted the development of numerous reformulations (1989)

In this study, to identify the zones, graphical formulation is discussed. It is worth noticing that similar results have been found in an earlier study(2000)

In this regard, a Bradford analysis involves the following steps: identification of the articles, listing in rank order journals containing corresponding articles, plotting a graph by putting the cumulative amount of articles on the Y-axis and the logarithm of the cumulative journals on the X-axis and determining the zones from the graph as shown in Figure 1.

Table 1: Organization of data in terms of articles per journal

Rank	Corresp. Articles	No of Journals	Cum. Journals (r)	Cum. Articles	Cum. % of Articles	Log Cum. Journals
1	268	1	1	268	7.19	0
2	261	1	2	529	14.2	0.3
3	255	1	3	784	21.05	0.48
4	177	1	4	961	25.8	0.6
5	149	1	5	1110	29.8	0.7
6	132	1	6	1242	33.34	0.78
7	83	1	7	1325	35.57	0.85
8	74	1	8	1399	37.56	0.9
9	69	1	9	1468	39.41	0.95
10	63	1	10	1531	41.1	1
11	60	1	11	1591	42.71	1.04
12	59	1	12	1650	44.3	1.08
13	52	2	14	1754	47.09	1.15
14	48	1	15	1802	48.38	1.18
15	47	1	16	1849	49.64	1.2
16	45	1	17	1894	50.85	1.23
17	39	2	19	1972	52.94	1.28
18	37	1	20	2009	53.93	1.3
19	36	1	21	2045	54.9	1.32
20	28	1	22	2073	55.65	1.36
21	27	1	23	2100	56.38	1.38
22	26	1	24	2126	57.07	1.4
23	24	1	25	2150	57.72	1.41
24	23	1	26	2173	58.34	1.43
25	22	2	28	2217	59.52	1.46
26	21	4	32	2301	61.77	1.52
27	20	1	33	2321	62.31	1.53
28	19	2	35	2359	63.33	1.56
29	18	1	36	2377	63.81	1.57
30	17	6	42	2479	66.55	1.63
31	16	5	47	2559	68.7	1.68
32	15	3	50	2604	69.91	1.71
33	14	3	53	2646	71.03	1.73
34	13	2	55	2672	71.73	1.75
35	12	8	63	2768	74.31	1.81
36	11	5	68	2823	75.79	1.84
37	10	4	72	2863	76.86	1.86

38	9	6	78	2917	78.31	1.9
39	8	7	85	2973	79.81	1.93
40	7	16	101	3085	82.82	2.01
41	6	15	116	3175	85.23	2.07
42	5	17	133	3260	87.52	2.13
43	4	31	164	3384	90.85	2.22
44	3	37	201	3495	93.83	2.31
45	2	50	251	3595	96.51	2.4
46	1	130	381	3725	100	2.58

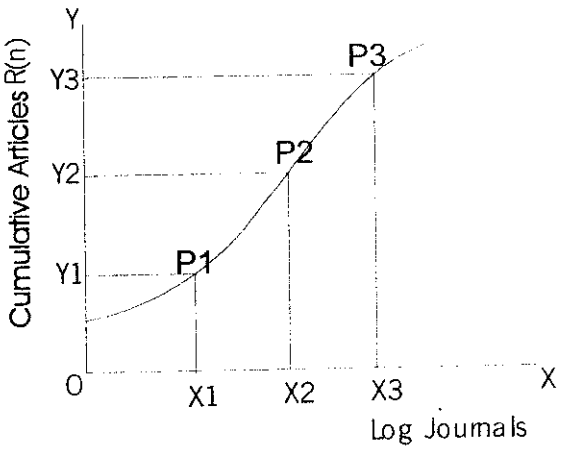

Fig. 1 - Demonstration of zones in Bradford plot

Along the X-axis, log n, journals have been ranked 1,2,3…n in decreasing order of productivity of papers relevant to ISAR on a logarithmic scale. Along the Y-axis cumulative totals of papers, R (n) is marked. When R (n) is plotted against log n, the graph begins with a rising curve which at a critical point (P1) runs into a straight line. From P1 two straight lines are drawn, P1X1 and P1 Y1 perpendicular against the X-and Y-axis. From the point Y2, where OY2=20Y1, and the point Y3, where OY3=30Y1, lines are drawn to the point P2 and the point P3 on the curve. The points X1,X2 and X3 show the logarithm of the numbers of core journals (X1), journals in Zone 2 (X2) and journals in Zone 3 (X3).

As stated earlier, the search in LISA on the topic ISAR resulted in 3725 records and the articles scattered to 381 journals. The Bradford distribution is shown in Figure 2. Three zones can be identified in this graph:

Zones	Journals	Articles	Percentage of all references
Zone1	007	1325	35.57
Zone2	046	2646	71.03
Zone3	328	3725	100.00

As it is revealed from the zones distributed within the graph, there is no observed data on P3 point. Moreover it is observed, that the last point of observed data (3725.383) borders the third zone. Expected number of journals on the point X3 is 381. Accordingly actual data distribution, as well as Bradford multiplier for three zones is as follows:

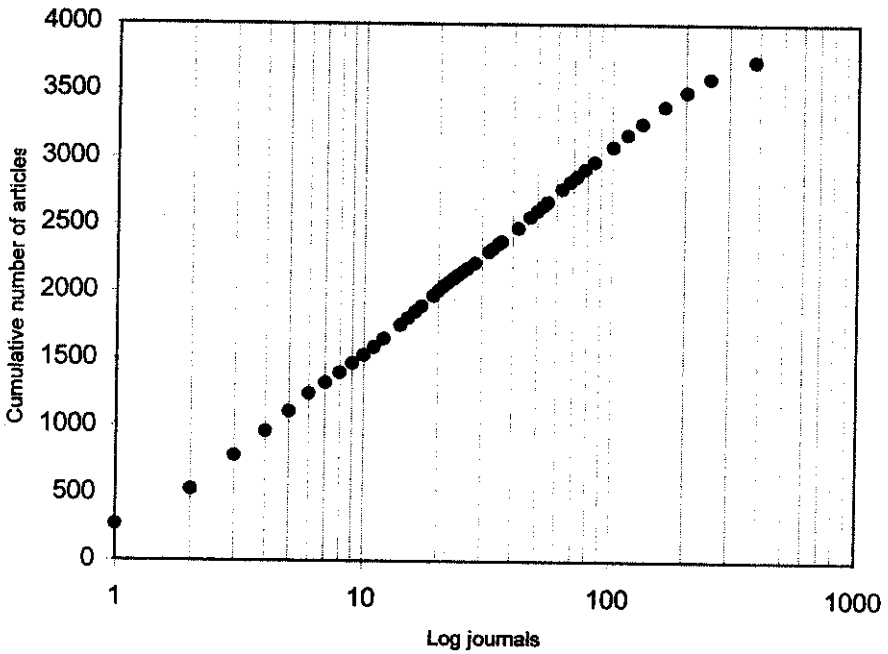

Fig 2: Bradford distribution of ISAR articles from 1981 to 2000.

Zones	Journal titles obtained	Corresponding Articles	Bradford multiplier
First	007	1325	---
Second	046	1321	6.57
Third	328	1079	7.13

B.C. Vickery (1948) noticed that the graph provided by Bradford was not necessarily equivalent to the statement "... *the number of periodicals in the nucleus and succeeding zones will be as 1, n, n^2, ...*" The calculated multipliers, in this data set, are 6.57, 7.13, fairly approximate the Bradford's verbal statement. As he found that for applied geophysics then, the number of journals in each zone was roughly proportionate to 1,5,25, (1950)

The shape of the graph(Nature of Bibliography)

The graph derived in this study according to the distribution of ISAR articles in different journals typifies the pattern of Bradfordian graphs. The graph initially appears as an upward curve before it becomes linear then it continues as a straight line. Then the line droops at its end. This is called the Groos droop. Groos (1967) discovered that journals in zones farther from the nucleus produce fewer articles than predicted. Brooks (1968) discussed the Groos droop and argued that the droop was an indication of the incomplete nature of the bibliography examined. His hypothesis was that the strength of the Groos droop reflects the (in)completeness of a bibliography.

Core Journals

The First zone of ISAR journals that includes 7 journals constitutes only 1.84 percent of journals and 35.57 percent of articles, i.e. the first zone has 7 journals contributing 1325 articles (Figure 2). The nucleus journals are: *Information Processing and Management; Journal of the American Society for information Science, Online; Database; Journal of Chemical Information and Computer Science; Online Information Review; and Journal of Information Science* containing 263,261, 255, 177, 149, 132 and 83 articles respectively. The second zone has 45 journals and 1321 articles indicating a slow decline in journal productivity and the third zone has a still higher rate of decline in journal productivity, 328 journals and 1079 articles. In the Bradfordian scene less number of journals account for the most of the articles concerned in the field. While more number of journals in related subject, comparatively, contributes less to the same field. This is the phenomenon of scatter of the articles.

Observed, Estimated and Expected Data

Brooks [3] according to Bradford who had believed that it is possible to take all of the numbers representing cumulative number of articles retrieved and to express them in a single mathematical formula expresses the following equation.

R(n)=b*log n/s

This formula is for estimating the cumulative number of articles (Table 2). In the formula, n is the rank for which one can predict, and R(n) is the corresponding cumulative number of articles.

Table 2: Observed cumulative number of articles against expected and estimated calculations according to Brooks equation and linear regression

Rank	Cum. Journals	Cum. Articles obs.R(n)	Expected	Estimated
1	1	268	108.67	0
2	2	529	548.69	440.02
3	3	784	806.09	697.42
4	4	961	988.71	880.04
5	5	1110	1130.4	1021.7
6	6	1242	1246.1	1137.4
7	7	1325	1344	1235.3
8	8	1399	1428.7	1320.1
9	9	1468	1503.5	1394.8
10	10	1531	1570.4	1461.7
11	11	1591	1630.9	1522.2
12	12	1650	1686.1	1577.5
13	14	1754	1784	1675.3
14	15	1802	1827.8	1719.1
15	16	1849	1868.8	1760.1
16	17	1894	1907.2	1798.6
17	19	1972	1977.8	1869.2
18	20	2009	2010.4	1901.7
19	21	2045	2041.4	1932.7
20	22	2073	2070.9	1962.2
21	23	2100	2099.1	1990.5
22	24	2126	2126.1	2017.5
23	25	2150	2152.1	2043.4
24	26	2173	2177	2068.3
25	28	2217	2224	2115.3
26	32	2301	2308.8	2200.1
27	33	2321	2328.3	2219.6
28	35	2359	2365.7	2257
29	36	2377	2383.5	2274.9
30	42	2479	2481.4	2372.7
31	47	2559	2552.8	2444.1
32	50	2604	2592.1	2483.4
33	53	2646	2629.1	2520.4
34	55	2672	2652.6	2543.9
35	63	2768	2738.8	2630.1
36	68	2823	2787.3	2678.6
37	72	2863	2823.6	2714.9

38	78	2917	2874.4	2765.7
39	85	2973	2928.9	2820.3
40	101	3085	3038.4	2929.8
41	116	3175	3126.3	3017.7
42	133	3260	3213.1	3104.5
43	164	3384	3346.1	3237.5
44	201	3495	3475.3	3366.6
45	251	3595	3616.3	3507.6
46	381	3725	3881.3	3772.6

By Selecting any rank, one can use the formula to calculate an estimate for the corresponding cumulative frequency. For example given a rank of three (here instead of rank one can use logarithm of cumulative journals because logically ranks for rows more than one journals have to be considered cumulatively in the calculation), this would calculate value of cumulative frequency close to the actual number of articles, 784, which appears in the table. In the formula the variables b and s are constants-different for each set of data. The calculated value of b is 1461.719 and s is one.

To predict the cumulative number of articles contained in the first five journals, find the log of five that is 0.70 (note that since s is equal to one it has no effect on this calculation) multiplying by the constant of 1462 gives 1022 as the estimated. The table gives the actual number 1110.The two figures are close to each other regarding the standards applied to laws in the social and behavioral sciences.

To calculate the value of b and s one can use Bradford graph (Figure 1). These can be calculated using the observed results of the search. The technique is called linear regression and formulas for it appears in many textbooks on statistics. The computer

software program called "Statistical Package for the Social Sciences (SPSS) is help to do these calculations. In linear regression calculation the value of b is the slope of the regression line and value of s is a measure of where the line hits the horizontal axis.

Linear Regression Analysis

Another way to calculate the expected figures for predicting the cumulative number of articles is regression analysis. This sort of analysis, which has been approved and used tremendously in statistical calculations, gives more precise and stabilized predictions comparing to the formula of Brooks.The formula of regression analysis is :

$$Y = \alpha + \beta * X$$

Y is predictor variable or dependent variable on Y-axis which is to be determined. α and β are constants, which are different in various data sets. X is any value of the independent variable in X-axis.

To calculate the value of α and β, linear regression analysis using the observed data could be performed on statistical packages such as SPSS. β is the slope of the regression line and α is the intercept, a measure of where the regression line hits the Y-axis. But, before the regression analysis is done, one presupposition has to be determined. One has to find out the degree of co-efficiency between the two variables, X and Y. For this analysis Pearson co-efficient test is done and the value of r is determined. This value is any figure between −1 and +1. If r is equal to +1 it means that the relation between two variables is complete strong and positive. Any increase in X variable will cause calculated increase in Y variable. If r is equal to Zero it means that there is no relation between two variables. If r is equal to −1, again the relations between the two variables are complete and strong but negative, i.e. any increase in X variable will cause calculated decrease in Y variable. In our study r=0.998 which means there is a strong co-efficiency between log (n) and R(n). P value is also 0.0001 which means the relation between the two variables is very significant. By applying the regression formula on the actual data it gives:

$$R(n) = 108.669 + 1461.719 (\log (n))$$

Accordingly all expected cumulative articles value is given in the fourth column of the Table 2 .On comparison two predicting calculation i.e. Brooks formula and regression analysis, it is noted that the latter is more realistic and closer to the observed data than the former one (Figure 3).

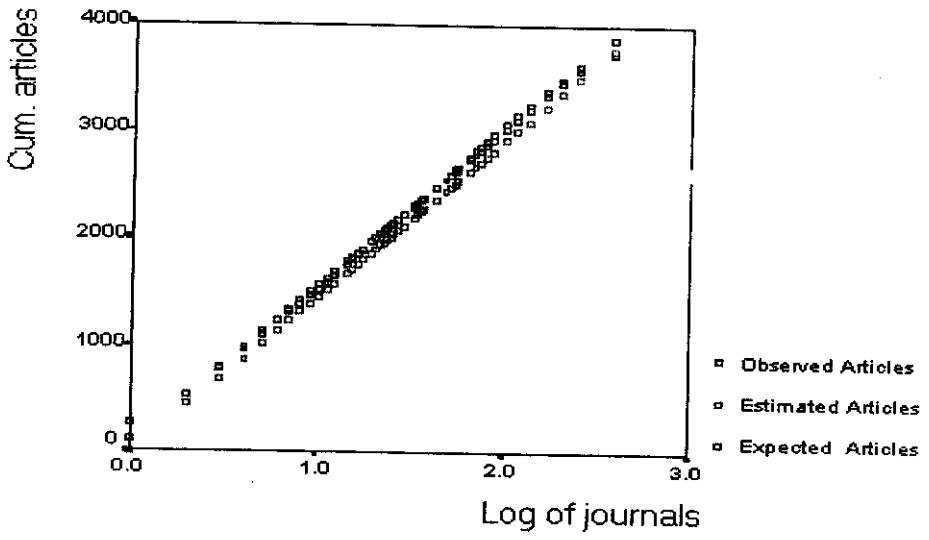

Fig 3: A comparison between observed data and expected & estimated calculation.

For example in the third rank the number of cumulative articles in observed data is 784. While in Brooks estimations it is 697, according to regression calculation it is 806, which is very closer to the observed data. The comparison between these two estimations reveals that regression analysis is more realistic more applicable and more predictable.

One of the applications of regression line is to check out how well the search was done by comparing the actual data to predicted retrieval. The closer the figures of the two columns of actual and prediction are, the more complete the bibliography search was done.

On comparison the quantities of the actual data with prediction through regression analysis it is seen that the bibliography compiled on ISAR has been done to a good extent.

Another application of the regression analysis in Bradford law is that one can extend the prediction to the quantity of Y-axis in the upper limits of the graph where little or no data are gathered. It is not yet close to this point with respect to the Bradford distribution, more theoretical work remains to be done.

According to the calculated quantities based on linear regression analysis the corresponding regression line was generated by computer using SPSS in Figure 4.This line shows the expected number of articles against observed number of articles according to the regression analysis.

Fig. 4: Comparison between observed and linear expected values

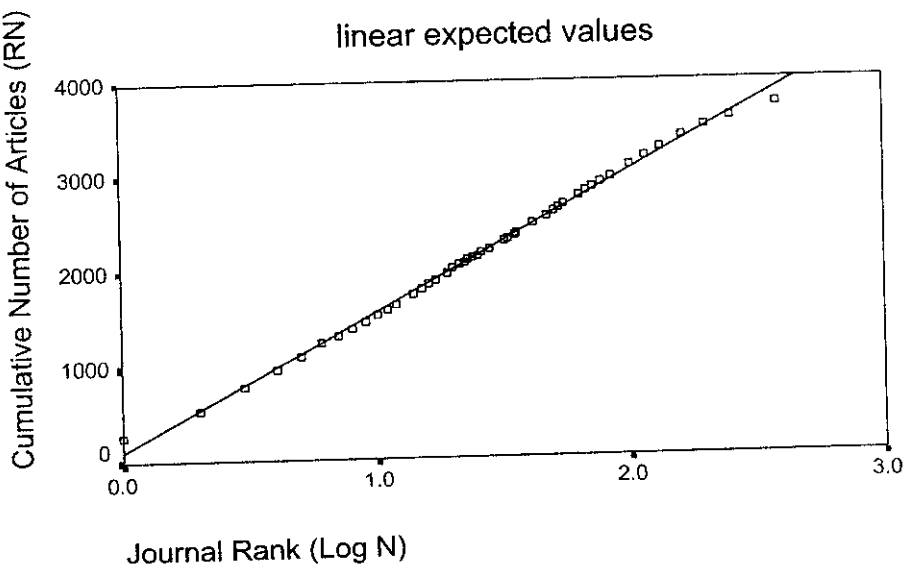

Fig 4: Comparison between observed and linear expected values.

Growth Rate

The amount of literature published in informatics covering ISAR during the twenty years period has sharp growth at one point of time this is so with the induction of new ICTs. The source of publications, which are mainly journals and conferences though remain static in number but the informatics coverage of ISAR started covering in more and more journals in the field. Thus, the articles and conference papers also increased sharply in numbers publishing each year.

Growth of Journals

To determine the rate and the manner of the growth of literature in the field of ISAR in different journals in the year 1981 through 2000, it was decided to examine the characteristics of this growth. The year-wise growth of literature in journals within twenty years is shown in Figure 5. It was found that the lowest level of the quantity of journals belongs to the year 1983 with 45 titles only. Except the year 1990 in which there is a rapid decline in the growth of journals, a fairly stabilized growth is observed from 1983 through 1995. The year 1995 has the highest quantity of the articles on ISAR in corresponding journals. In a simple comparison it is seen that the journals, which have published articles in the field of ISAR, have been three folded from the year 1983. The growth line shows also a sharp decline in the number of journals participating in ISAR literature from 1997 up to 1999. Within these 3 years the range has fallen from more than 120 titles in 1997 to about 69 titles in 1999. This rapid decrease in the number of participating periodicals in ISAR literature is a matter of high consideration that has to be investigated. One reason may be that within these years there is a rapid growth in internet resources and electronic publishing. So some literature in ISAR has diverted to this direction.

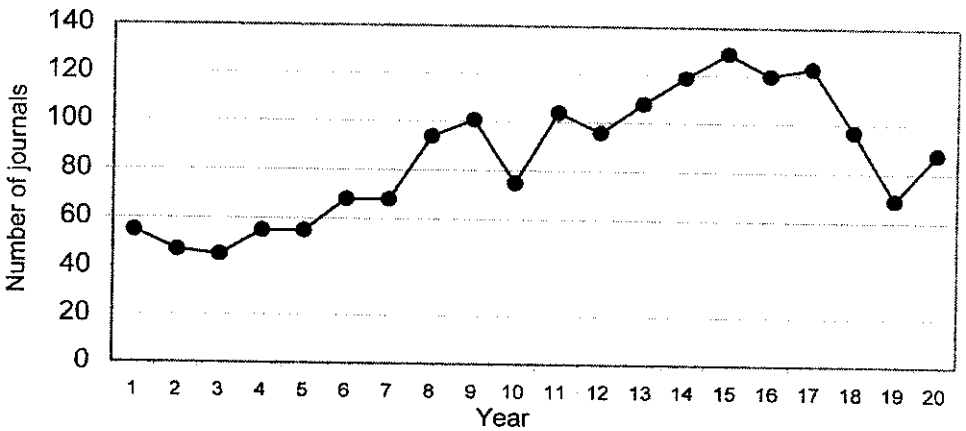

Fig 5: Growth rate of journals in ISAR from 1981 to 2000.

On the whole the number of periodicals in 1990s is much more than in 1980s and it further shows that there is a continual growth in the ISAR in the number of periodicals.

Most Productive Journals

To find out the pattern of emergence of most productive periodicals (first twenty journals) in time zones (Figure 6), it was revealed that 8 journals comprising 940 articles (47% of total most productive journal's articles) were established within 1960's and before. On the other hand in 1970's only 5 high ranking journals emerged, which consist 706 articles and 35% of total high ranking journals. Again in 1980s it is noted that 6 journals consisting only 15% of the total most productive journals were published for the first time. In 1990's only one journal with mere 52 articles (3%) was published.

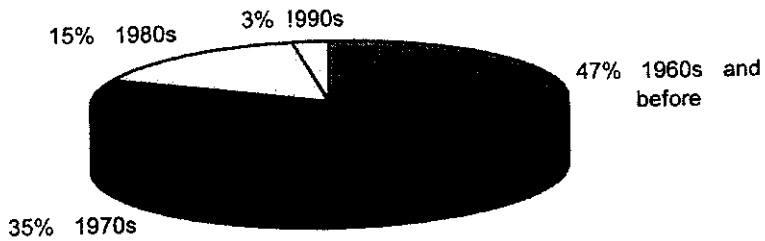

Fig 6: Growth of journals on ISAR in different decades.

A comparison between the time spans shows that the older journals account for more literature in ISAR than the newly published ones. All of the 7 core journals were also established before 1980.

The most productive journals are found to consist of one monthly, 6 bimonthly, 7 quarterly and 6 with different frequencies which some of them have irregular time intervals(Figure 7). The monthly journal produced a total of 177 articles (9%). Bimonthly, quarterly and journals with irregular frequencies produced 974 (45%), 364 (78%) and 554 (28%) articles respectively. Out of 7 core journals 4 with 804 articles are bimonthly and 1 journal with 177 articles is monthly and two other journals are journals with irregular frequencies.

The analysis by the published body reveals that as many as 13 journals (65%) are from commercial agencies and learned bodies. Associations and research societies publish 7 journals. Non-commercial agencies, such as American Library Association are mostly from USA.

Country-wise analysis of journal productivity reveals that USA, UK and Netherlands are the only countries, which produce the highly ranked journals in the area of ISAR. USA with 11 journals (55%), UK with 8 journals (40%) and Netherlands only with 1 journal (5%) are the most productive countries in the field of ISAR (Figure 8). Journal wise India has no share in the most productive countries in ISAR. Also, in total journal productivity India has a negligible share

in article productivity. Again USA, UK and Netherlands have 1221 articles (67%), 751 articles (37%) and 37 articles (2%) respectively published in ISAR literature. Further the ultimate production of developed countries, as against the developing countries, is very much evident from the analysis.

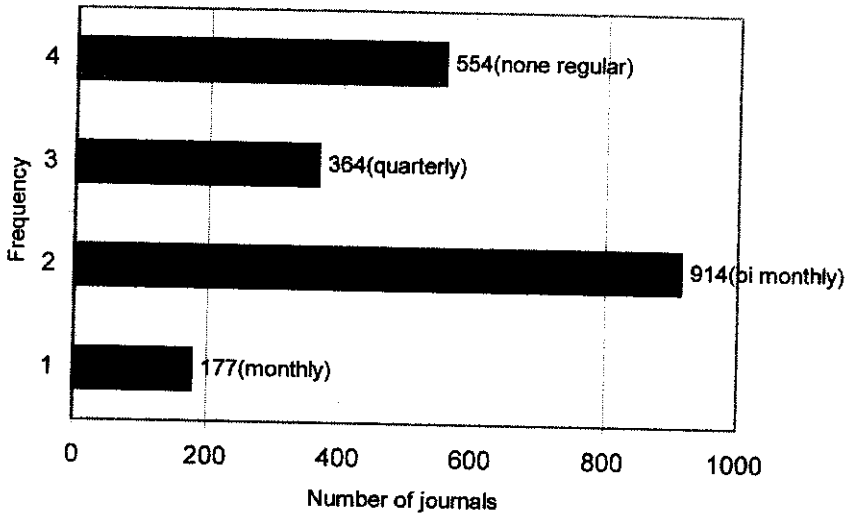

Fig 7 : Frequency distribution of journals in ISAR.

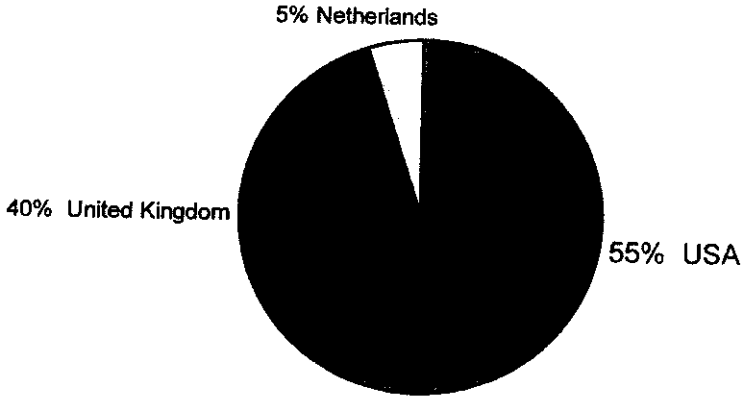

Fig 8 : Countrywise distribution of journals in ISAR.

Table 3: Top Twenty Journals in CISAR during 1981-2000

Year / Journal	198	198	198	198	198	198	198	198	198	199	199	199	199	199	199	199	199	199	199	200	Tota	%	Rank
IPM	8	9	4	3	10	4	19	18	21	16	16	10	23	18	19	16	16	23	2	13	268	13.3	1
JASIS	7	6	9	6	5	11	8	9	10	12	17	9	13	12	22	22	12	28	18	25	261	12.9	2
Online	11	15	13	9	18	16	9	13	11	10	8	16	21	15	16	12	11	13	1	17	255	12.6	3
Database	3	5	7	9	9	16	12	15	16	7	8	11	16	11	6	8	8	10	0	0	177	8.81	4
JCICS	8	6	5	6	13	5	3	4	7	4	15	13	9	19	6	9	13	4	0	0	149	7.42	5
Online Information Review	13	5	11	9	6	10	7	5	10	6	7	4	8	4	2	3	5	3	6	8	132	6.57	6
JIS	2	6	4	0	2	6	3	2	3	4	5	6	5	11	1	3	2	6	2	10	83	4.13	7
Information Today	0	0	0	0	2	0	1	0	0	2	1	3	2	0	2	8	12	20	13	8	74	3.68	8
MRSQ	0	3	5	5	7	6	4	10	4	3	2	3	2	1	2	2	6	3	0	1	69	3.43	9
Journal of Documentation	0	5	1	3	1	1	5	0	1	6	3	3	3	3	5	4	4	4	3	8	63	3.14	10
Program	4	3	0	6	2	9	2	5	3	3	2	2	2	3	2	1	2	2	2	5	60	2.99	11
WPI	2	0	3	1	8	7	5	2	5	4	5	4	1	3	1	1	3	1	1	2	59	2.94	12
Searcher	0	0	0	0	0	0	0	0	0	0	0	0	0	5	6	2	8	15	10	6	52	2.59	13
ITL	0	2	6	1	0	3	7	5	3	1	2	4	5	1	6	5	0	1	0	0	52	2.59	13
BMLA	2	1	1	3	2	1	1	5	5	1	0	2	4	2	2	2	5	3	2	4	48	2.39	14
Electeronic Library	0	0	2	1	2	2	2	2	1	2	5	4	3	3	4	1	2	2	3	6	47	2.34	15
Reference Librarian	0	8	0	0	0	4	4	3	6	3	0	0	0	2	1	10	1	2	0	1	45	2.24	16
RQ	1	5	1	3	5	1	1	2	3	1	3	2	1	4	3	1	2	0	0	0	39	1.94	17
IWR	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	2	5	8	7	13	39	1.94	17
ISU	2	1	1	3	2	1	4	3	4	2	1	2	1	1	0	4	3	1	0	1	37	1.84	18
Total	63	80	73	68	94	103	97	103	113	87	100	98	122	118	107	116	120	149	70	128	2009	100	

The year-wise feature of top twenty most productive journals in the field of ISAR is shown in Table 3. *Journal of the American Society for Information Science* in 1998 published 28 articles in the ISAR field, which is the highest rate ever. Through all twenty years under study the year 1998 with 149 articles is the most productive year in the area of ISAR. While in the year 1981 only 63 articles were published in ISAR field. Out of 7 core journals, two journals i.e. *Database* and *Journal of Chemical Information and Computer Science* have published zero articles in 1999 and 2000. This may be because of change in policy or other reasons, which have a high effect on the total lower productivity of articles in 1999 (70 articles) and 2000 (128 articles) respectively. Moreover, out of total twenty journals, 7 journals have either seized publishing articles in the area of ISAR or published only one article in 1999 and 2000. This is also another reason for declining of article productivity during 1999 to 2000.

Growth of Articles

Literature in ISAR almost does not have a steady growth rate from 1981 to 2000 as shown in Figure 9. But in the first decade i.e. 1980s the growth is steady. In the year 1981 there were only 120 articles, whereas in the year 1996 the number of articles rose to 304. Out of the period and journals studied, 120 articles happen to be the minimum number of articles in a year. In 1990s the growth rate is in rising position. From 1990 to 1996 and from this year onward the growth rate drops considerably specially in 1999, to 153 articles only. And again there is a considerable growth in 2000 from 153 articles to 262 articles.

From 1981 to 1989 only 36% of all literature were produced in ISAR. While during 1990-1999, 58% of the total literature was produced. Comparing the two figures it

is noted that there is a considerable growth in 1990s. The year 2000 shares only 6% of the literature that is above the average (5%) of all years.

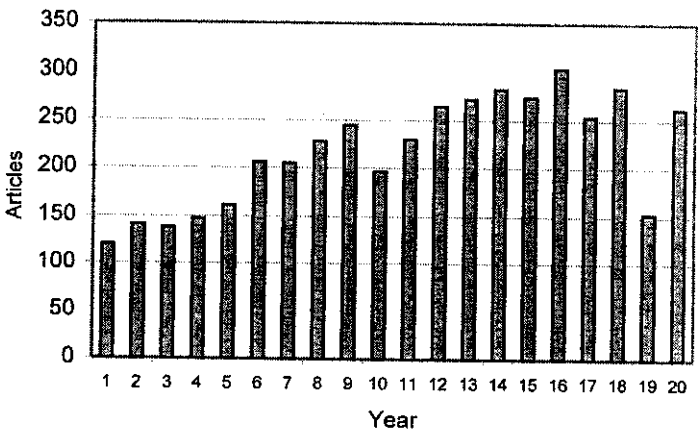

Fig 9: Growth of article in ISAR from 1981 to 2000.

There might be many reasons for the decline in the growth rate of literature after mid 1990s. One reason, as stated earlier also, might be that it has been observed that apparently the general tendency towards electronic publishing and uses of Internet for scientific communication have increased considerably. Another reason might be that the field of ISAR has reached some maturity or some sort of clinks because of some reasons, which is to be investigated in a fresh research.

The growth of literature is divided in five blocks of four years to portray a clearer situation as shown in Table 4. The yearly growth rate has also been calculated by dividing cumulative contribution to the cumulative years. The outcome is an average, which shows the yearly growth in each block of four years. The growth rate of literature in the first block is 136.5 articles/years. While in the fourth block it is noted that the growth rate is 218.35 articles/years. It has been observed that the general tendency in the growth rate of literature has a sustainable increase.

Table 4: Growth rate of journal articles in four year blocks in ISAR

Four Year Blocks	Contributions C.	C/4	Cum. Cont.	Cum. Year(t)	Growth= Cum. Cont./t
1981 - 1984	546	136.5	546	4	136.5
1985 - 1988	800	200	1346	8	168.25
1989 - 1992	936	234	2282	12	190.17
1993 - 1996	1132	283	3414	16	213.37
1997 - 2000	953	238.25	4367	20	218.35

Conclusions

The literature search using LISA in the area of Informatics in Information Storage and Retrieval for the period of twenty year from 1981 to 2000 resulted 3725 articles from 381 journals. The ranking of the journals and their respective contributions identified the important journal titles or the select items for weeding.

Bradford`s physical analogy of a comet structure on literature nucleus and the law proved in the area of ISAR on the selected data. The nucleus journals identified amounts to seven journals with *Information Processing and Management, Journal of American Society for Information Science and Journal of Information Science* as first, second and seventh respectively in this set of data. Calculations of cumulative number of articles using mathematical formula using observed, estimated and expected data followed Bradford analysis.

The method of linear regression analysis has also been confirmed for the predicting the cumulative number of articles using $Y = \alpha + \beta * X$ formula. Results of regression analysis found that the bibliographic compiled on ISAR has been done to nearest extent.

Growth rate of the journals during the period study found that the lowest level of the number of journals belongs to year 1983 with 45 titles. There has been fairly

stabilized growth is observed from 1983 through 1995 with a clink in the year 1990. A sharp decline in number of journals from 1997 up to 1999 has been noted, this may be because of rapid growth in internet and electronic publishing.

The most productive journals are seven. Out of seven core journals four with 804 articles are bimonthly and one journal with 177 articles is monthly. The developed countries contributed maximum with USA 11 journals (55%), UK 8 journals (40%) and Netherland one journal (5%). JASIS in 1998 published 28 articles in ISAR, which is the highest rate ever. Growth rate of articles has not been steady during the period 1981-2000. In the year 1981 there was only 120 articles, where as in the year 1996 it increased to 304. From 1990 to1996 growth rate increased and from 1996 onward growth rate drops sharply and again there is considerable increase in 2000 from 153 to 262 articles. In spite it has been observed that there is sustainable increase in the literature.

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LIST OF ABBREVIATIONS USED FOR JOURNALS

Abbreviations	Full Form of the Journal
BMLA	Bulletin of Medical Library Association
IPM	Information Processing and Management
ISU	Information Services and Use
ITL	Information Technology and Libraries
IWR	Information World Review
JASIS	Journal of the American Society for Information Science
JCICS	Journal of Chemical Information and Computer Science
JIS	Journal of Information Science
MRSQ	Medical Reference Services Quarterly
WPI	World Patent Information