Annals of Library and Information Studies
Vol. 68, June 2021, pp. 135-144

# A scientometric analysis and visualization of the 50 highly cited papers of Eugene Garfield

Shriram Pandey[a] & Dinesh K Gupta[b]

[a] Assistant Professor, Department of Library and Information Science, Banaras Hindu University, Varanasi, India, E-mail: shriram.lib@bhu.ac.in

[b] Professor and Head, Department of Library and Information Science, Central University of Haryana, Mahendragarh, Haryana, Email: dineshkg@cuh.ac.in

*6 September 2020; revised: 13 May 2021; accepted: 16 May 2021*

Eugene Garfield's contribution to the global informetrics and scientometrics research is significant. In this paper, a scientometric analysis of Eugene Garfield's 50 highly cited papers is performed. His papers were published in 32 journals including top-ranked journals such as *Nature* and *Science*. The top 15 keywords with the strongest citation bursts from 1989 to 2009 and references with strong citation bursts are presented. Co-citation analysis and bibliographic coupling analysis based on source journals using VOSviewer were carried out. The result revealed that keywords 'citation relationship', 'scientific journals', 'biological journal' and 'self-citations' started to burst/hotspot in 2002. The term 'citation analysis' has the highest number of four years' popularity as citation burst. The study further revealed that the top 50 publications of Eugene Garfield gained 8441 citations of the total citations of 9121 from 254 published documents. Garfield has Total Link Strength of 35 and has received 8511 citations which comes to 93.31% of the total citations and proved his dominance over the collaborators. Ninety percent of the papers (45) published in the USA and above 92% of the citations (8419) were also received from the USA's publications. Just five papers in three journals received 4856 citations (53.23%) of the total 9121 citations. These three journals include three papers in *Science* (with 3027); one each in *Journal of the American Medical Association* (with 1323 citations) and *The Canadian Medical Association Journal* (with 606 citations).

**Keywords:** Eugene Garfield; Citation Index; Citation Burst; Citation Matrices; Visualization

## Introduction

Eugene Garfield (September 16, 1925-February 26, 2017) was a renowned information scientist who developed the citation index. Garfield view of the citation indexing first appeared in the journal *Science*[1]. This article is one of his most highly cited articles[2]. His article on impact factor for the journals entitled, "The history and meaning of the journal impact factor" is also one of the most influential articles in his career[3]. Another significant contribution made by Garfield was coining of the term "Garfield's Constant" in 1976[4&5]. Although Garfield has made several research contributions as a sole contributor, he also has several co-authored publications with several scientists from other institutes. Eugene Garfield was active researcher in an interdisciplinary field, and his papers are indexed extensively in multi-disciplinary databases[6].

Garfield, the founder of the Institute of Scientific Information, now (Clarivate Analytics), created the "Web-of-Science" database that is widely used for undertaking scientometric studies[7]. Eugene Garfield contributions are also visible over the web in forms of commentaries, reviews, web pages, and interviews. The most important contributions made by Garfield are theory of citation analysis, the Citation Indexes as products, the Impact Factor and the use of JCR data[8]. The paper published in the *Journal of American Medical Association (JAMA)* is the most cited reference by the set of publications merged from the Web of Science and Scopus[9]. We have referred numerous studies related to contribution of Garfield such as Masic & Begic[10] which overs 1,538 published papers, 1,534 of which are cited; the 9,077 citations of his works with an h-index of 155. Sen[11] highlights that Garfield contributed one article every week in *Current Contents* and other journals. In all, around 1500 articles appeared in the 'Essays of an Information Scientist' in 15 volumes. This study discusses the first five volumes.

Jacso[12] records Garfield's 6,500 citations (from his journal articles, conference papers, reviews, essays, commentaries, letters to the editors, and that his publications) received, and could be credited to a

matching record in the master file of Web of Science analyses on different parameters. Rousseau, and Hu[13] finds ten Garfield's articles (among 31) that belong to the category of under-cited influential work, be it that they all belong to the top 10% level (hence cited at most 200 times). Bornmann, Haunschild & Hug[14] studied keyword co-occurrence networks based on the context of citations, which are referenced in a certain paper sets published by Garfield. Leydesdorff [15] analyses using title words, co-authors, and journal names in Garfield's oeuvre (or document sets), and visualized at each moment of time, and over time. Jacso [16] presents scientometric profile of E Garfield using the ResearcherID service, and the WoS Core Collection (WoS).

As such, studies on Garfield have concentrated on either his personality portrait or studies on Web of Science or quantitative output from Garfield or his less known publications. It seems that there is no scientometric study of Garfield's highly cited publications. The present paper investigates Garfield's 50 highly cited published works and their metrics using scientometrics indicators.

## Objectives of this study

- To identify and examine the 50 most-cited papers of Eugene Garfield from a scientometric standpoint;
- To analyse the co-authorship pattern; and
- To analyse inter-citation network and keywords mapping, citations burst, co-citation timeline analysis, and profoundly influencing co-citations.

## Methodology

The Scopus online database was searched to identify the publications mentioning the search string query:AU-ID ("Garfield, Eugene" 7005088140) on April 28, 2020. Scopus database was chosen for extracting the data because it has wide coverage as compared to Web of Science (WoS). The complete list of 50 highly cited documents is listed in Appendix I. The retrieved publications were sorted in descending order of their citation count. The 50 most cited papers of Eugene Garfield were identified, and their bibliographic data were extracted and assessed for further analysis. The authors considered the top 50 papers based on the citations received by these papers and did not set any threshold value for number of citations or time window. The VOSviewer[17] and CiteSpace[18] data analysing tool is used to generate a map and visualizes the influence of these papers.

## Analysis

As per the Scopus database, Garfield published a total of 254 papers. He has also published many reports and grey literatures. A statistical summary of his contributions is given in Table 1.

Out of these, nine journals have published two or more articles. *Scientist* is the most productive journal with 6 papers, followed by *Scientometrics* (4 papers) and *Science* (3 papers).

## Co-authorship cluster

Co-authorship analysis was performed to have a better understanding of research collaboration among the scientific community[19]. Garfield has contributed 30 papers without any collaborators and 10 papers under joint authorship (Two authors; 2 papers, Three authors; 5 papers, Four authors; 2 paper and Six authors; 2 papers). A total of 26 authors who have network links with Garfield are displayed in Figure 1. VOSviewer calculates clusters based on two weight attributes/strength namely Link and Total link strength (TLS). In this case of co-authorship network, Links denotes the number of co-authorship links of an author with other authors. The Total link strength attribute denotes the total strength of the co-authorship links of a given author with other authors. The higher value of TLS indicates the higher number

Table 1 — Eugene Garfield's contributions

| | |
|---|---|
| Published Documents | 254 |
| h-Index | 34 (as on April 28, 2020) |
| Affiliation | Institute for Scientific Information |
| City | Philadelphia |
| Country/Territory | United State of America |
| Articles | 110 |
| Notes | 70 |
| Letters | 45 |
| Reviews | 16 |
| Conference Papers | 7 |
| Editorials | 4 |
| Errata | 1 |
| Short Surveys | 1 |
| Open Access articles | 8 |
| Other (subscription) | 246 |
| Total citations | 9121 (as on April 28, 2020 ) |
| Cited by | 6642 |
| Co-authors | 86 |
| References | 1204 |
| Highest cited paper | Citation analysis as a tool in journal evaluation, 1972, *Science* 178(4060), pp. 471-479 : Cited by 1543 |

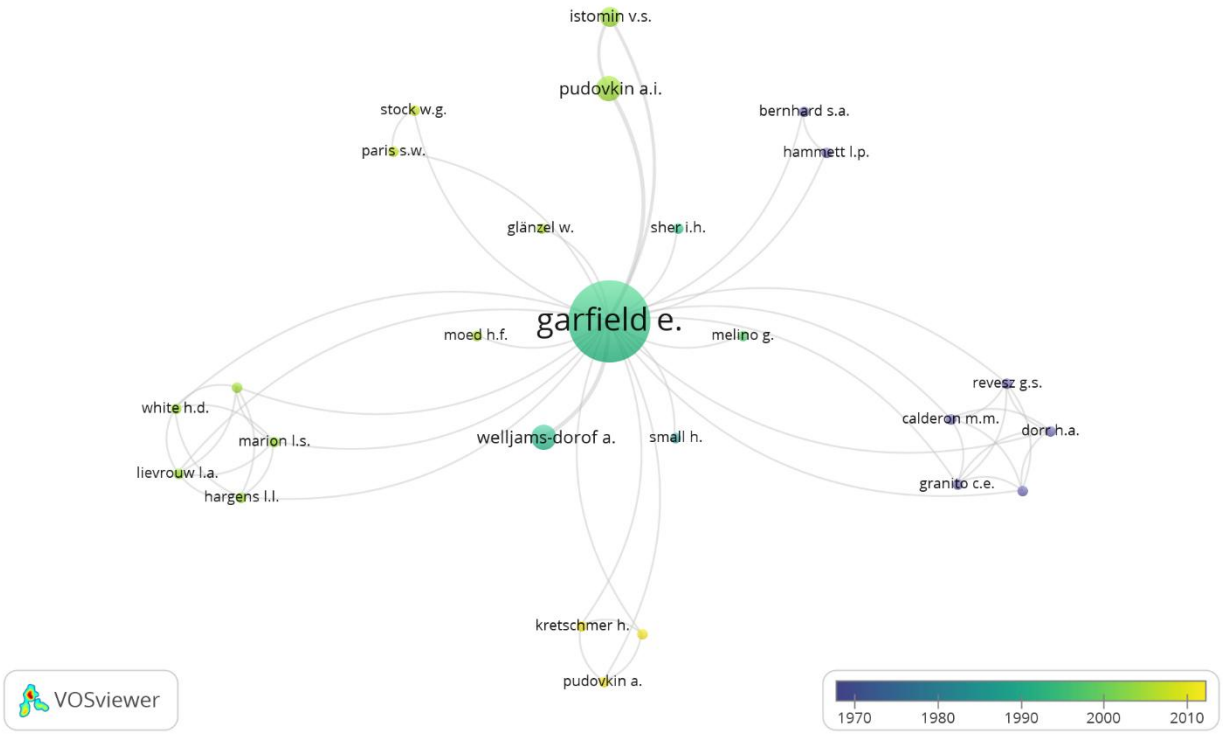


Fig. 1 — Co-author network of document based on their associated link

of co-authorship links with other authors. VOSViewer created a total of 10 clusters and authors are grouped across clusters based on weight of link and total link strength[20]. From the figure, it can be seen that the most prolific authors are usually located in the core of the network, and the distance between them is shortest. The result revealed that the most publishing author Garfield has Total Link Strength 35 received 8511 citations in total. Pudovkin A.I. has published 5 papers with Garfield with a TLS value is 8. The top 5 authors with the largest total link strength were Garfield E. (TLS=35), Pudovkin A.I.(TLS=8), Istominv.s (TLS=6), elljams- Dorof A .(TLS=5), Calderon M.M.(TLS=5).

**Keyword mapping**

Keyword co-occurrence mapping reflects the research hotspots and acts as a catalytic tool for scientific research. We conducted a keyword mapping of 50 most-cited documents of Eugene Garfield and co-authors. This was done by analysing co-occurrence of keywords mapping using VOSviewer; the keywords density visualization map is shown in Figure 2. The size of the nodes and words in Figure 2 depicted the weights of the nodes. Size of the node is directly proportionate to weight. It means that a bigger node and words would have a larger weight. The relations between two nodes are identified by distance. A shorter distance represents a stronger relationship. The line between two keywords represents togetherness. The thicker the line represents the more co-occurrence among nodes and words[21]. The nodes with the same colour belong to a cluster.

Out of 160 keywords, we have chosen keywords whose minimum occurrence is one. In total, 160 keywords qualified for the network grouped into 10 clusters. The most repeated keyword (frequency=12, TLS=83) in cluster-6 is 'bibliometrics'. This keyword has strong associations medical literature (frequency=10, TLS=74) and Citation Analysis (frequency=7, TLS=59) in cluster-9 and with periodicals (frequency=9, TLS=59) from cluster 1. The top 10 keyword clusters based on their weightage & occurrences are given in Table.2.

Centrality is a major indicator of the importance of nodes in a network, and a higher centrality means that a node is more important in a network, so the results as given in Table 2 shows that 'Abstracting and indexing' has higher centrality value which means

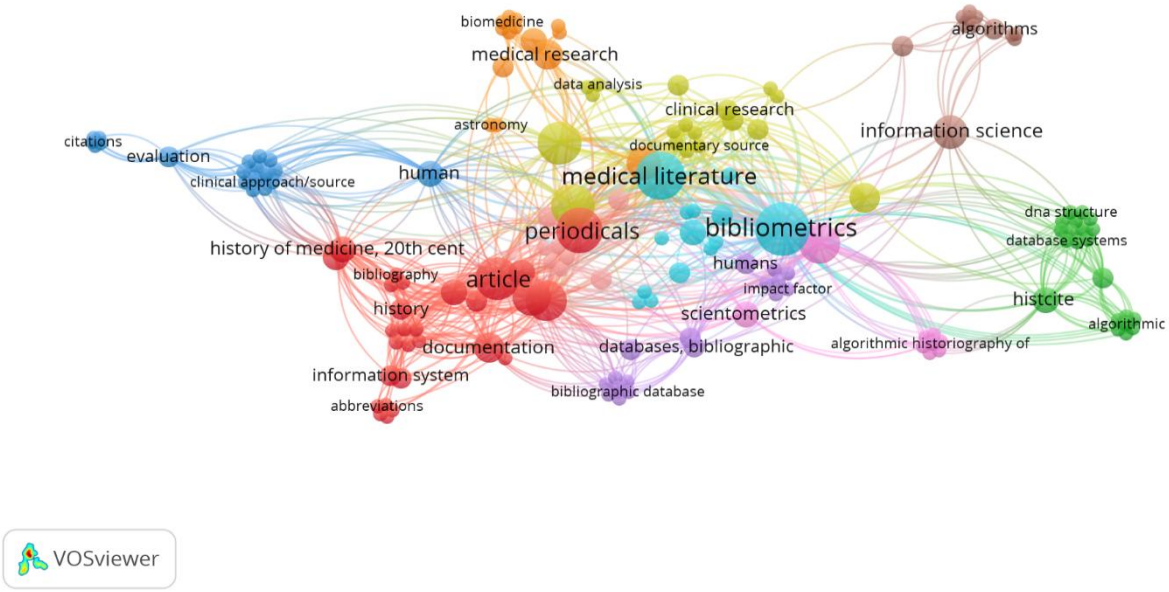


Fig. 2 — Keyword clusters Network Visualization on their weightage & occurrences

Table 2 — The top 10 Keyword clusters based on their weightage & occurrences

| Rank | Cluster | Keywords | Frequency | Centrality | Total Link Strength | Average appearing years (AAY) | Average citations |
|---|---|---|---|---|---|---|---|
| 1 | 6 | Bibliometrics | 12 | 0.013 | 83 | 2001.42 | 230.00 |
| 2 | 6 | Medical Literature | 10 | 0.013 | 74 | 1998.70 | 268.56 |
| 3 | 9 | Citation Analysis | 7 | 0.013 | 59 | 2000.86 | 63.57 |
| 4 | 1 | Periodicals | 9 | 0.013 | 58 | 1993.33 | 467.89 |
| 5 | 1 | Abstracting and indexing | 7 | 0.094 | 56 | 1986.29 | 81.00 |
| 6 | 1 | Science | 6 | 0.013 | 39 | 1980.67 | 337.00 |
| 7 | 10 | Information Retrieval | 4 | 0.013 | 35 | 2004.67 | 72.75 |
| 8 | 1 | Research | 3 | 0.013 | 31 | 1987.67 | 121.33 |
| 9 | 1 | History Of Medicine | 3 | 0.013 | 31 | 1983.00 | 167.33 |
| 10 | 1 | Documentation | 4 | 0.013 | 27 | 1976.75 | 432.00 |

that abstracting and indexing is most significant research area.

As seen from Figures 2 & 3, six and nine are positioned close to each other in the visualization network while at the same time, cluster one is little far away. This shows the close association between the keywords in these 6 & 9 clusters compared with the cluster-1 depicted in Fig. 3.

The keywords of Eugene Garfield highly cited publications appeared during different periods are represented using overlay visualization (Fig. 2). The blue links represent the keyword density and occurrence before 1980's. The colour blue slightly shifted to green from 1981 to 2000. Later, the blue lines turn yellow after 2001. Before 1990, the research of that period was focused on 'abstracting& indexing', 'documentation',' Science', 'History of Medicine' etc. which shifted to 'scientometrics', 'bibliometrics', 'citation analysis', ' priority journals', 'periodicals' and there is increased research found during this period and many publications are on these areas. After 2001 the research trends declined as compared to 1990 to 2000, and it is found that the research from 2000 onwards was concentrated on 'information science', 'information dissemination', 'information processing', 'histcite', 'clinical research' and algorithm.

**Top keywords with the strongest citation bursts**

The citation bursts represent fast-growing topics and highly relevant areas and research hotspot. Citation bursts determine the period in which keywords emerged [22&23]. The top 15 keyword having highest citations burst is identified using CiteSpace (Figure 4). Each keyword with citations bursts

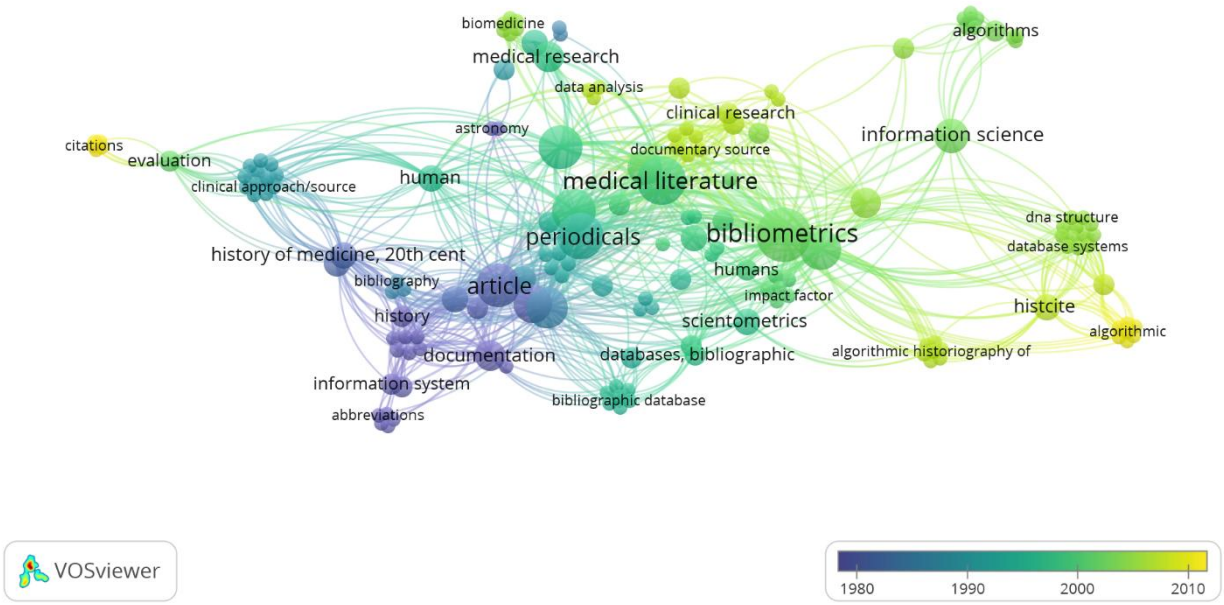


Fig. 3 — Keyword clusters overlay visualization over the period on their weightage & occurrences

| Keywords | Year | Strength | Begin | End | 1989 - 2009 |
|---|---|---|---|---|---|
| science citation index | 1989 | 0.6269 | **1992** | 1992 | |
| scientific literature | 1989 | 0.6269 | **1992** | 1992 | |
| scientometrics | 1989 | 0.6269 | **1992** | 1992 | |
| nobel prize | 1989 | 0.6269 | **1992** | 1992 | |
| citation analysis | 1989 | 1.0138 | **1992** | 1996 | |
| citation impact | 1989 | 0.6269 | **1992** | 1992 | |
| diskette | 1989 | 0.6931 | **1993** | 1993 | |
| co citation | 1989 | 0.6534 | **1998** | 1998 | |
| model | 1989 | 0.6534 | **1998** | 1998 | |
| document | 1989 | 0.6534 | **1998** | 1998 | |
| department | 1989 | 0.6534 | **1998** | 1998 | |
| citation relationship | 1989 | 0.6534 | **2002** | 2002 | |
| scientific journal | 1989 | 0.6534 | **2002** | 2002 | |
| biology journal | 1989 | 0.6534 | **2002** | 2002 | |
| self citation | 1989 | 0.6534 | **2002** | 2002 | |

Fig. 4 — The top 15 keywords with the strongest citation bursts during 1989 to 2009

represents the corresponding characteristics in each time period.

Most of the keywords started to burst in 1992 and the keywords 'citation relationship', 'scientific journals', 'biological journal and 'self-citations' started to burst in the year 2002. The term 'citation analysis' has highest citation burst in four years.

## Co-citation & bibliographic coupling

Co-citation analysis and bibliographic coupling analysis based on source journals using VOSviewer were carried out, and output is represented in Figures 5 & 6. Figure 5 represents the journal (source) co-citation network with 25 nodes with criteria that the minimum number of citations of a source is 5. The

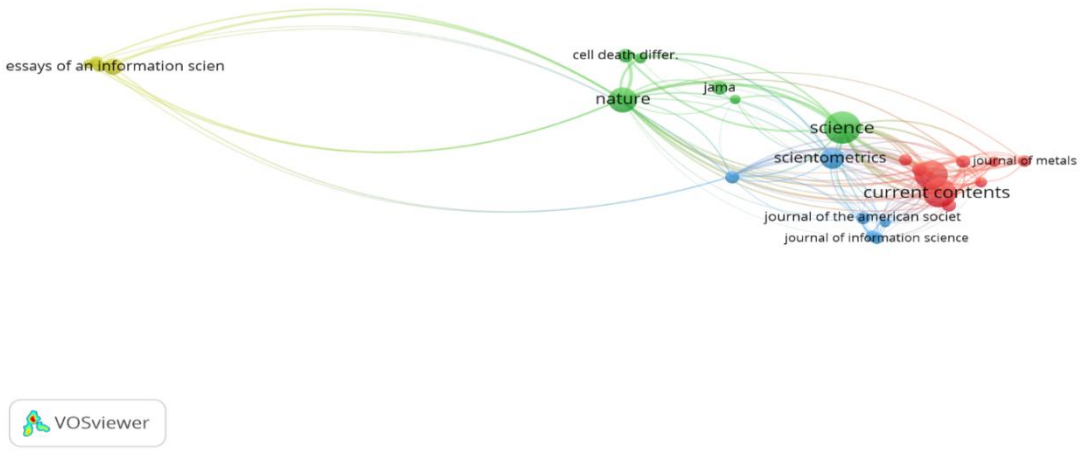


Fig. 5 — Journal co-citation based on source

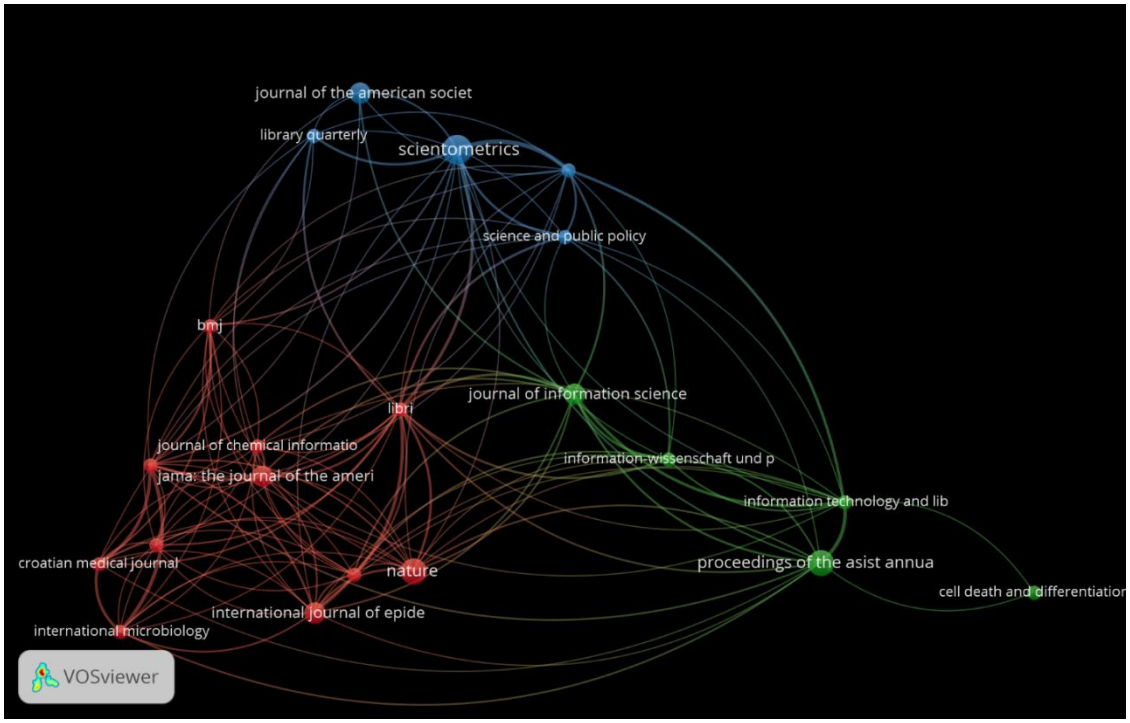


Fig 6 — Journal Bibliographic coupling based Source

size of the node represents the number of published papers by the journal. As indicated in the results of co-citation of source, the 50 most-cited publications are categorized into four clusters based on the works cited in these publications. Larger clusters include more publications, and the distance between two clusters indicates the relatedness of the clusters in terms of their citations. Clusters that are located close to each other in the network tends to be strongly related in terms of their citations. In contrast, clusters that are positioned further away from each other indicate that the cited works in these groups of publications are not so similar. The results revealed that *Essays of an Information Scientist* (vol 1, 3, 4,5) (TS = 70, TLS = 1457, cluster - 4) received highest co-citations by sources followed by *Current Contents* (TS = 44, TLS = 836, cluster - 1), *Science* (TS = 53, TLS = 688, Cluster - 2) and *Scientometrics* (TS = 22, TLS = 261, Cluster - 3).

It is shown in Figure 6 that out of 32 sources, only 21journals appeared in terms of their total link strength (TLS) to indicate the journal influence. The top 5 journals appeared in three clusters, having the largest total link strength were as follows: *Libri* (TLS

= 49), *Scientometrics* (TLS = 39), *Journal of the American Medical Association-JAMA* (TLS = 38), *Journal of Information Science* (TLS = 32), *Theoretical Medicine* (TLS = 32).

Another timeline visualization of the co-citation major clusters formed by references cited in publications is represented in Fig 7. The cluster colour represents the time when co-citation connections were made for the first time in the dataset. The top-level cluster denotes the most recent references cited in publications. It is clearly visualized from the top clusters that Garfield's contributions to citation index were the most cited references (document co-citation network) clusters appeared in most years in the time frame.

**Cluster view of a co-citation network**

Each timeline runs from the left to the right. Most of the co-citation clusters indicates citations indexing whereas Clusters 0 & 1 contain a series of highly cited articles (Fig. 7). It is also seen in Fig. 7 that most of the clusters (Custers 2, 3, 6, 7 and 10) indicates the "citation index" as a thematic cluster. It means that Garfield's work is mostly concentrated towards the citation index

**References with strong citation bursts**

Publications that received particular attention to the scientific communities over time and to find out potential research directions have been identified (Fig. 8). Publications that experienced citation bursts are

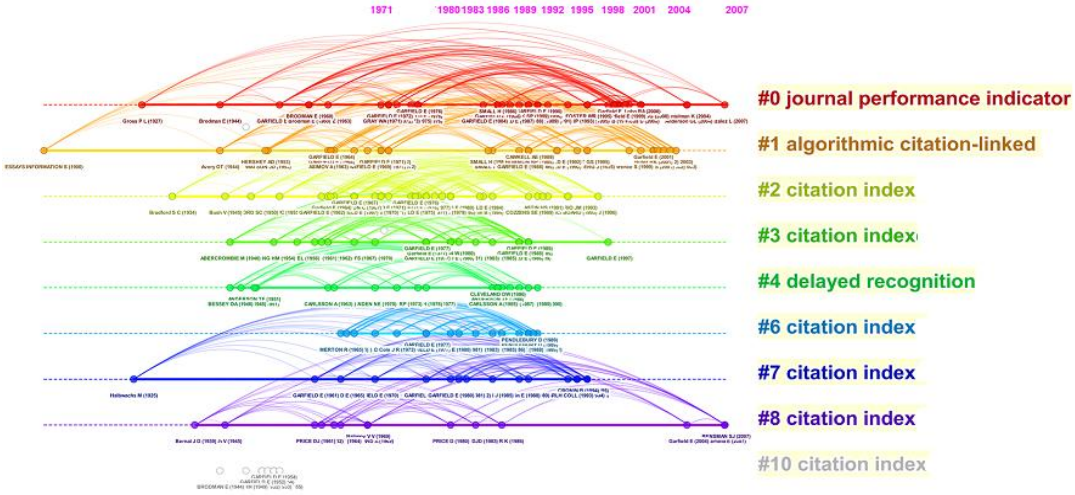


Figure 7 — Timeline visualization of the co-citation clusters

| References | Year | Strength | Begin | End | 1989 - 2009 |
|---|---|---|---|---|---|
| ZUCKERMAN H, 1986, NATURE, V324, P629, DOI | 1986 | 0.8604 | **1989** | 1992 | |
| GARFIELD E, 1985, ESSAYS INFORMATION S, V7, P175 | 1985 | 1.0328 | **1990** | 1992 | |
| GARFIELD E, 1990, CURR COMMENTS, V0, P3 | 1990 | 1.0242 | **1992** | 1996 | |
| Garfield E, 1996, SCIENTIST, V10, P13 | 1996 | 0.7484 | **1998** | 2002 | |
| Hansen HB, 1997, CLIN PHYSIOL, V17, P409, DOI | 1997 | 1.3506 | **1998** | 2000 | |
| Bensman SJ, 1998, LIBR RESOUR TECH SER, V42, P147, DOI | 1998 | 1.188 | **1999** | 2000 | |
| Garfield E, 1998, SCIENTIST, V12, P12 | 1998 | 1.2074 | **1999** | 2006 | |
| Hoeffel C, 1998, ALLERGY, V53, P1225, DOI | 1998 | 1.2074 | **1999** | 2006 | |
| Garfield E, 1998, SCIENTIST, V12, P10 | 1998 | 1.2074 | **1999** | 2006 | |
| Opthof T, 1999, CARDIOVASC RES, V41, P1 | 1999 | 1.2074 | **1999** | 2006 | |
| VANLEEUWEN TN, 1997, CHEM INTELLIGENCER, V3, P32 | 1997 | 1.188 | **1999** | 2000 | |
| CAWKELL AE, 2000, WEB KNOWLEDGE FESTSC, V0, P177 | 2000 | 1.2311 | **2002** | 2003 | |
| Garfield E, 2002, P ASIST ANNU, V39, P14, DOI | 2002 | 1.3001 | **2003** | 2004 | |
| Garfield E, 2003, J AM SOC INF SCI TEC, V54, P400, DOI | 2003 | 1.6499 | **2003** | 2009 | |
| Pudovkin AI, 2004, P ASIST ANNU, V41, P507, DOI | 2004 | 1.2484 | **2006** | 2007 | |

Figure 8 — The top 15 references with the strongest citation bursts during 1989-2009

visualized with a total of 42 bibliographic records that were identified from 515 valid references. The length of the line represents the period from 1989 to 2019 in which publications received higher attention. The red line represents the time period of citation bursts. More bursts arise during 1998-2009.

## Conclusions

Eugene Garfield is one of the pioneers of the study of citation data. Studying his classical works and major works that made him famous is always useful for getting an insight of his personality and works, his philosophy and practice. He developed theories and products that has been attracting the attention of the researchers for decades. The study present offers an understanding of the works of E. Garfield and their citations worldwide. Any researcher working on the areas of informetrics, scientometrics and altimetric may find results of this study useful for further study and analysis by correlating the research findings. Future researches may also be conducted on qualitative evaluation of these papers specially on seminal papers and using h-index or h-classics as a parameter. A systematic review and meta-analysis of these seminal papers may give a better understanding of mapping of concepts, keywords and its co-occurrence network.

## References


1 Garfield E, Citation analysis as a tool in journal evaluation, *Science*, 178 (4060) (1972) 471–479. https://doi.org/10.1126/science.178.4060.471

2 Wouters P, Eugene Garfield (1925–2017), *Nature*, 543(March) (2017) 2017.

3 Rousseau R, Under-cited influential work by Eugene Garfield, *Scientometrics*, 114(2) (2018) 651–657. https://doi.org/10.1007/s11192-017-2530-8

4 Garfield E. Significant journals of science, *Nature*, 264(5587) (1976) 609–615. https://doi.org/10.1038/264609a0

5 Schubert A, and Schubert G, Whatever happened to Garfield's constant?, *Scientometrics*, 114(2) (2018, 659–667. https://doi.org/10.1007/s11192-017-2527-3

6 Glänzel W and & Abdulhayoğlu M A, Garfield number: on some characteristics of Eugene Garfield's first and second order co-authorship networks, *Scientometrics*, *114*(2) (2018) 533-544.https://doi.org/10.1007/s11192-017-2623-4

7 Li L Z, Leydesdorff L, Nioka S, and Sun N, Citation analysis of the scientific publications of Britton Chance in ISI citation indexes, *Journal of Innovative Optical Health Sciences*, 7(2) (2014) 1–14. https://doi.org/10.1142/S1793545814300031

8 Bar-ilan J, Eugene Garfield on the Web in 2001. *Scientometrics*, 114(2) (2018) 389–399. https://doi.org/10.1007/ s11192-017-2590-9

9 Garfield E, The history and meaning of the Journal impact factor, *Journal of the American Medical Association*, 295(1) (2006), 90–93. https://doi.org/10.1001/jama.295.1.90

10 Masic I and Begic E, Scientometric Dilemma: Is H-index Adequate for Scientific Validity of Academic's Work?, *Acta informatica medica : AIM : journal of the Society for Medical Informatics of Bosnia* , 24(4) (2016) 228–232. https://doi.org/10.5455/aim.2016.24.228-232

11 Sen B, Eugene Garfield-Glimpses of his writings, *Journal of Scientometric Research*, 3(1) (2014) 57-60. https://doi.org/10.4103/2320-0057.143709

12 Jasco P, The impact of Eugene Garfield through the prism of Web of Science, *Annals of Library and Information Studies*, 57(3) (2010) 222–247.

13 Rousseau R and Xiaojun H, Under-cited influential work by Eugene Garfield, *Scientometrics,* 114 (2) ( 2018) 651-657.

14 Bornmann L, Haunschild R and Hug S E, Eugene Garfield : a new type of keyword co-occurrence analysis. *Scientometrics*, 114(2) (2018) 427–437. https://doi.org/10.1007/s11192-017-2591-8

15 Leydesdorff L, Eugene Garfield and Algorithmic Historiography: Co-Words, Co-Authors, and Journal Names, *Annals of Library and Information Studies*, 57(3) (2010) 248–260.

16 Jacso P, The scientometric portrait of Eugene Garfield through the free ResearcherID service from the Web of Science Core Collection of 67 million master records and 1.3 billion references, *Scientometrics*, 114(2) (2018) 545–555. https://doi.org/10.1007/s11192-017-2624-3

17 Van Eck N J and Waltman L, Software survey: VOSviewer, a computer program for bibliometric mapping, *Scientometrics*, 84(2) (2010), 523-538.

18 Chen C, Ibekwe-SanJuan F and Hou J, The structure and dynamics of co-citation clusters: A multiple-perspective co-citation analysis. *Journal of the American Society for Information Science and Technology*, 61(7) (2010) 1386–1409.

19 Li H, An H, Wang Y, Huang J and Gao X , Evolutionary features of academic articles co-keyword network and keywords co-occurrence network: Based on two-mode affiliation network. *Physica A: Statistical Mechanics and Its Applications,* 450(2016) 657–669. https://doi.org/10.1016/j.physa.2016.01.017B

20 Van Eck N.J, Waltman L, Software survey: VOSviewer, a computer program for bibliometric mapping, *Scientometrics*, *84*(2) (2010) 523-538

21 Belli, S., Mugnaini, R., Baltà, J. , Ernest,Abadal, Coronavirus mapping in scientific publications: When science advances rapidly and collectively, is access to this knowledge open to society?, *Scientometrics* 124(2020) 2661–2685 .https://doi.org/10.1007/s11192-020-03590-7

22 Liao Huchang, Ming Tang Li Luo, Chunyang Li Francisco Chiclana and Xiao-Jun Zeng, A bibliometric analysis and visualization of medical big data research, *Sustainability* 10(1) (2018) 166.

23 Li F, Li M, Guan P, Ma S and Cui L, Mapping publication trends and identifying hot spots of research on Internet health information seeking behavior: a quantitative and co-word biclustering analysis, *Journal of medical Internet research*, *17*(3) (2015) e81. https://doi.org/10.2196/jmir.3326

## **Appendix-I:** Garfield's 50 Highly Cited Papers (as on on April 28, 2020)

| Rank | Article | Citations |
|---|---|---|
| 1 | Garfield E, Citation analysis as a tool in journal evaluation, *Science*, 178 (4060) (1972) 471-479. | 1542 |
| 2 | Garfield E, The history and meaning of the journal impact factor, *Journal of the American Medical Association*, 295 (1) (2006) 90-93. | 1323 |
| 3 | Garfield E, Citation indexes for science, *Science*, 122 (3159) (1955) 108-111. | 1297 |
| 4 | Garfield E,Journal impact factor: A brief review, *CMAJ*, 161 (8) (1999) 979-980. | 506 |
| 5 | Garfield E, Is citation analysis a legitimate evaluation tool?, *Scientometrics*, 1 (4) (1979) 359-375. | 435 |
| 6 | Garfield E,Fortnightly Review: How can impact factors be improved? *BMJ*, 313 (7054) (1996) 411-413. | 380 |
| 7 | Garfield E,Citation indexing for studying science*Nature*, 227 (5259) (1970) 669-671. | 227 |
| 8 | Garfield E,Science citation index - A new dimension in indexing, *Science*, 144 (3619) (1964) 649-654. | 118 |
| 9 | Garfield E,100 Citation Classics From The Journal of the American Medical Association, *JAMA: The Journal of the American Medical Association*, 257 (1) (1987) 52-59. | 183 |
| 10 | Pudovkin AI, Garfield E, Algorithmic procedure for finding semantically related journals, *Journal of the American Society for Information Science and Technology*, 53 (13) (2002) 1113-1119. | 161 |
| 11 | GarfieldE,Which medical journals have the greatest impact?, *Annals of Internal Medicine*, 105 (2) (1986)313-320. | 140 |
| 12 | Small H, Garfield E,The geography of science: Disciplinary and national mappings, *Journal of Information Science*, 11 (4) (1985) 147-159. | 136 |
| 13 | Garfield E,Historiographic mapping of knowledge domains literature, *Journal of Information Science*, 30 (2) (2004) 119-145. | 131 |
| 14 | Garfield E, Welljams-Dorof A, Citation data: Their use as quantitative indicators for science and technology evaluation and policy-making,*Science and Public Policy*, 19 (5) (1992) 321-327. | 127 |
| 15 | Garfield E,From the science of science to Scientometrics visualizing the history of science with HistCite software, *Journal of Informetrics*, 3 (3) (2009) 173-179. | 123 |
| 16 | Garfield E, Pudovkin AI, Istomin VS,Why do we need algorithmic historiography?, *Journal of the American Society for Information Science and Technology*, 54 (5) (2003) 400-412. | 110 |
| 17 | Garfield E,The evolution of the science citation index, *International Microbiology*, 10 (1) (2007) 65-69. | 98 |
| 18 | Garfield E, Welljams-Dorof A,Of Nobel class: A citation perspective on high impact research authors,*Theoretical Medicine*, 13 (2) (1992) 117-135. | 92 |
| 19 | Garfield E,Citation indexes for science. A new dimension in documentation through association of ideas,*International Journal of Epidemiology*, 35 (5) (2006)1123-1127. | 81 |
| 20 | Garfield, E,Significant journals of science, *Nature*, 264 (5587) (1976) 609-615. | 79 |
| 21 | Pudovkin AI, Garfield, E,Rank-normalized impact factor: A way to compare journal performance across subject categories,*Proceedings of the ASIST Annual Meeting*, 41(2004) 507-515. | 77 |
| 22 | Garfield E,The significant scientific literature appears in a small core of journals,*Scientist*, 10 (17) (1996)13. | 77 |
| 23 | Garfield E, Random thoughts on citationology. Its theory and practice,*Scientometrics*, 43 (1) (1998) 69-76. | 71 |
| 24 | Garfield E, Long-term vs. short-term journal impact: Does it matter?, *Scientist*, 12 (3) (1998). | 62 |
| 25 | Garfield E, The impact factor and using it correctly [Der impact faktor und seine richtigeanwendung] *Unfallchirurg*, 101 (6) (1998) 413-414. | 59 |
| 26 | Garfield .,Use of Journal Citation Reports and Journal Performance Indicators in measuring short and long term journal impact, Croatian Medical Journal, 41 (4) (2000) 368-374. | 58 |
| 27 | Garfield E, Welljams-Dorof A, The Impact of Fraudulent Research on the Scientific Literature: The Stephen E. Breuning Case, *JAMA: The Journal of the American Medical Association*, 263 (10) (1990) 1424-1426 | 55 |
| 28 | Garfield E, From citation indexes to informetrics: Is the tail now wagging the dog?, *Libri*, 48 (2) (1998) 67-80. | 53 |
| 29 | Garfield E, What is the primordial reference for the phrase 'Publish Or Perish'?, *Scientist*, 10 (12) (1996) | 53 |
| 30 | Garfield E, Sher IH, KeyWords Plus™—algorithmic derivative indexing, *Journal of the American Society for Information Science*, 44 (5) (1993) 298-299. | 49 |
| 31 | Garfield E, Paris SW, Stock WG, HistCite™: A software tool for informetric analysis of citation linkage,*Information-Wissenschaft und Praxis*, 57 (8) (2006) 391-400. | 46 |

(*Contd*.)

| Rank | Article | Citations |
|---|---|---|
| 32 | Garfield E, Impact factors, and why they won't go away , *Nature*, 411 (6837) (2001) 522. | 45 |
| 33 | Glänzel W, Garfield E, The myth of delayed recognition, *Scientist*, 18 (11) (2004). 8. | 44 |
| 34 | Garfield E, Welljams-Dorof A, Language Use in International Research: A Citation Analysis, The ANNALS of the American Academy of Political and Social Science, 511 (1) (1990) 10-24. | 44 |
| 35 | Garfield E, Pudovkin AI., Istomin VS, Mapping the Output of Topical Searches in the Web of Knowledge and the Case of Watson-Crick,*Information Technology and Libraries*, 22 (4) (2003) 183-187. | 32 |
| 36 | Garfield E, When to cite,.*Library Quarterly*, 66 (4) (1996)449-458.. | 32 |
| 37 | Garfield E, Pudovkin AI, Istomin VS, Algorithmic Citation-Linked Historiography - Mapping the Literature of Science, *Proceedings of the ASIST Annual Meeting*, 39(2002) 14-24. | 28 |
| 38 | Garfield E, The impact factor and its correct application [Der impact faktor und seine richtigeanwendung], *Anaesthesist*, 47 (6) (1998) 439-441. | 28 |
| 39 | Garfield E, Dispelling a few common myths about journal citation impacts, *Scientist*, 11 (3) (1997) 11 | 25 |
| 40 | Garfield E, History of Citation Indexes for Chemistry: A Brief Review, *Journal of Chemical Information and Computer Sciences*, 25 (3) (1985) 170-174. | 25 |
| 41 | Garfield E, Quantitative analysis of the scientific literature and its implications for science policymaking in Latin America and the Caribbean,) *Bulletin of the Pan American Health Organization*, 29 (1) (1995) 87-95. | 21 |
| 42 | Moed, HF, Garfield E, In basic science the percentage of 'authoritative' references decreases as bibliographies become shorter, *Scientometrics*, 60 (3) (2004) 295-303. | 20 |
| 43 | Garfield E, Commentary: Fifty years of citation indexing, *International Journal of Epidemiology*, 35 (5) (2006) 1127-1128. | 19 |
| 44 | Marion L S, Garfield E, Hargens LL, Lievrouw, LA, White H.D, Wilson CS,Social network analysis and citation network analysis: complementary approaches to the study of scientific communication, *Proceedings of the ASIST Annual Meeting*, 40 (2003) 486-487. | 19 |
| 45 | Garfield E, Melino G,The growth of the cell death field: An analysis from the ISI-Science citation index,*Cell Death and Differentiation*, 4 (5) (1997) 352-361. | 19 |
| 46 | Garfield E, Revesz GS, Granito, CE, Dorr H A, Calderon, M M, Warner, A.Pragmatic Approach to Substructure Chemical Retrieval, Journal of Chemical Documentation, 10 (1) (1970) 54-58. | 19 |
| 47 | Bernhard SA, Garfield E, Hammett LP, Specific Effects in Acid Catalysis by Ion Exchange Resins. III. Some Observations on the Effect of Polyvalent Cations, *Journal of the American Chemical Society*, 76 (4) (1954) 991-992. | 19 |
| 48 | Pudovkin A, Kretschmer H, Stegmann J, Garfield E, Research evaluation. Part I: Productivity and citedness of a German medical research institution, *Scientometrics*, 93 (1) (2012) 3-16. | 18 |
| 49 | Garfield E, Welljams-Dorof A, The microbiology literature: Languages of publication and their relative citation impact, *FEMS Microbiology Letters*, 100 (1-3) (1992)33-37. | 18 |
| 50 | Garfield E,I had a Dream ... about uncitedness, *Scientist*, 12 (14) (1998) | 17 |