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On the Formation of the Concept of Informetrics (Review)

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Abstract—The history and modern approaches to the definition of the concept of informetrics, including a new line of research, viz., alternative metrics, are considered. Factors that have influenced the process of active development of informetrics in recent years are presented.

Keywords: informetrics, bibliometrics, scientometrics, webometrics, altmetrics, object of study, subject of study, field of study, line of research, scientific concepts, information production processes

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INTRODUCTION

In 1988, in VINITI the monograph *Informetrics* by V.I. Gor'kova was published [1]. In our opinion, in the Russian scientific literature and curriculum for information and library professionals this line of research is not given due attention.

Meanwhile, in recent years all over the world there has been a surge of interest in so-called metrics (bibliometrics, scientometrics, informetrics, etc.). The problem of the correct use of the methodology of this approach is the subject of extensive discussion in the scientific community. Experts have expressed concern about the lack of competence in the field of informetrics of the majority of scientists, research managers, scientific policy makers, etc. [e.g., 2, 3]. Under these circumstances, the task of forming the "informetric" literacy of scholars, library and information specialists, and university teachers is of particular relevance. Our analysis [4] showed that today in foreign countries educational programs in the field of informetrics are popular and actively implemented.

What factors have determined the development of informetrics in recent years? What are the reasons for the increased interest in informetrics and other metrics? Which specialists currently understand under the term *informetrics?* How do different metrics relate to each other?

We attempted to find answers to these questions using a range of modern foreign sources that have been rarely quoted in Russia earlier or not considered at all.

INFORMETRICS AS AN IMPORTANT FIELD OF RESEARCH

The process of mathematization of science contributes to the emergence and development of independent disciplines that provide quantitative methods for the study of various objects and processes, such as econometrics, sociometry, biometrics, psychometrics, and quantitative linguistics.

Informetrics is a rapidly growing field of research that is related to the study of all quantitative (mathematical, statistical, and probabilistic) aspects of information, information processes, and phenomena. Informetric research is aimed at identifying the empirical (statistical) regularities in these processes, explaining the obtained mathematical relationships, and developing informetric models and, ultimately, the theory.

The history of informetrics (as a field of research not as a term) have begun in the early 20th century with the quantitative research in the fields of psychology [5] and legal science [6]. Empirical foundations were laid in the first half of the 20th century by such scientists as A. Lotka, S. Bradford, and G. Zipf. Works of D. Price, E. Garfield, R. Merton, V. Nalimov, etc., can truly be considered fundamental.

Over the years informetrics evolved from the "invisible college" into an independent scientific discipline with an actively functioning International Society for Scientometrics and Informetrics (ISSI) and regularly conducted international conferences on scientometrics and informetrics (http://www.issi-society.info/). Since 1978, the Journal *of Scientometrics* has been available. In 2007, the Elsevier publishing house started to publish the first journal in the world containing the word informetrics in its title, i.e., the international *Journal of Informetrics* (http://www.journals.elsevier.com/journal-of-informetrics/). This fact reflects not only the growth and expansion of research in the field of informetrics but also the importance and recognition of its scientific status [7, 8].

Informetrics is one of the few truly interdisciplinary research areas that extends to almost all scientific fields. Informetrics borrows tools (methods, models, and analogies) from mathematics, physics, computer science, mathematical linguistics, and other quantitative sciences. On the other hand, it is used or addressed to areas such as library science, sociology of science, history of science, science policy, and information retrieval [9, 10].

According to the authors of [11], in the history of informetrics several stages can be singled out associated with the evolution of informetric analysis tools, i.e., manual data processing, system support of informetric studies, automated processing of data and use of professional software, network data processing, as well as a modern stage of imaging and intelligent information processing.

Currently, informetrics is going through a stage of rapid development. We believe that this process is associated with the following factors.

1. Progress in the field of information and communication technologies, which provides unprecedented possibilities for the access, exchange, and processing of scientific data [12].

According to the well-known German scientist W. Glänzel [9], the breakthrough in this area was due to the following reasons:

(1) The widespread availability of citation databases.

(2) The development of hardware.

(3) The development of software.

(4) The organization of the network and the possibility to conduct online research.

2. Further development of models and methods of informetrics related to the formation of new fields of research (webometrics), development of modern methods of mapping and visualization of scientific areas, introduction of new indicators (*h*-index), etc. In addition, the launch of two new citation databases Scopus and Google Scholar had a significant influence on the development of informetrics [13]. More and more regional citation databases appear (e.g., in China, Latin America, Russia, Taiwan, and Japan).

3. The active use of bibliometrics and scientometrics in science policy and management of the financing of science, in national programs of development of science, and national systems of assessment of research results. As examples, we can cite Research Quality Assessment Programs in the United Kingdom (Research Assessment Exercise) and Australia (Excellence in Research for Australia). In Russia, the predicted values of scientometric indicators are set in the Strategy of Innovative Development of the Russian Federation up to 2020 and the Decree of the President of the Russian Federation of May 7, 2012, no. 599 On Measures for Implementation of the State Policy in Education and Science.

4. The use of bibliometric and scientometric indicators in the preparation of national and international rankings of universities.

5. Changes in the system of scientific communication related to the widespread use of electronic information resources of the Internet and the international movement for open access to scientific and humanities knowledge.

To date, numerous monographs, reviews, and bibliographies on informetrics and its subdomains have been published (bibliometrics, scientometrics, webometrics, etc.). In particular, we denote works by V.V. Nalimov and Z.M. Mul'chenko [14], S.D. Haitun [15], V.I. Gor'kova [1], I.V. Marshakova-Shaikevich [16, 17], S.A. Rozhkov [18], H.D. White and K.W. McCain [19], C.L. Borgman and J. Furner [20], M. Thelwall, L. Vaughan, and L. Björneborn [21], a dictionary of bibliometric terminology by V. Diodato [22], etc. We note in particular the textbook by L. Egghe and R. Rousseau [10], as well as reviews by C.S. Wilson [23] and J. Bar-Ilan [13].

The background and analysis of terminology (up to 2001) can be found in a review article by W.W. Hood and C.S. Wilson [24], as well as in a number of Russian works by authors such as O. Voverene [25], O.V. Pen'kova, V.M. Tyutyunnik [26], N.S. Red'kina [27, 28], A.A. Pronin [29], S.V. Bredikhin, and A.Yu. Kuznetsov [30].

Further, we consider a brief history and modern approaches to the definition of *informetrics*. However, we will not dwell on the analysis of the many definitions and interpretations of the terms *bibliometrics* and *scientometrics* made by different experts in different years. We confine ourselves to some of the most important definitions in the context of the emergence of the modern concept of *informetrics*.

FROM LIBRAMETRY TO INFORMETRICS

According C.S. Wilson [23], P. Otlet was the first person who used the term *bibliométrie* as a system of measures related to the book and the document in 1934 in his "Traite de Documentation" [31] and, in fact, was 35 years ahead of the widespread definition made by A. Pritchard [32].

In 1948, at the AsLib conference the Indian scholar and librarian S.R. Ranganathan [33] used the term *librametry* by analogy with the terms *econometrics* and *biometrics* to refer to the measurement of the quantitative data directly related to the work of libraries, but this term did not receive scientific recognition .

According to many scientists, the term *bibliometrics* first occurred in the work of A. Pritchard (1969) who defined it as "the application of mathematical and statistical methods to books and other media of communication" [32]. This definition was given as an alternative to the ambiguous term *statistical bibliography* proposed in 1923 by E.W. Hulme. The ambiguity resulted from two possible interpretations of this phrase as statistics of bibliography and bibliography of statistics.

I.V. Marshakova-Shaikevich [16, 17] defined bibliometrics as a research field associated with a quantitative study of documentary flows. The objects of study in bibliometric research are publications grouped by various criteria, i.e., the authors' names, titles of journals, subject headings, countries, etc. Various bibliometric methods can be reduced to two methodological approaches. The first approach is "simple" bibliometrics associated with the identification of the dynamics of individual objects of study (publications, authors, and keywords) and their distribution by country, category of scientific journal, etc. The second is structural bibliometrics, which identifies relationships between objects, their correlation, and classification. If the first approach consists in obtaining quantitative assessments of the characteristics of a scientific phenomenon, the second provides a structural (qualitative) picture of the state of science.

C.L. Borgman, J. Furner [20], and M. Thelwall [34] indicated the three types of bibliometric studies, namely, *descriptive, relational, and evaluative bibliometrics*.

Descriptive bibliometrics focuses on characteristic features of literature related to geographic areas, time periods, disciplines, etc.

Relational bibliometrics is devoted to the exploration of relationships within the study, such as the cognitive structure of the field of research, the emergence of new research fronts, and national and international examples of the joint authorship.

Evaluative bibliometrics is aimed at the evaluation of the impact of a scientific work and the comparison of the relative scientific contributions of two or more scientists (research groups). These evaluations are used for decision-making in the formation of the research policy, resource allocation, and research funding.

According to W. Glänzel [9], bibliometric studies cover the following subdomains of modern bibliometrics.

Bibliometrics for professionals involved in bibliometrics (bibliometricians). This is an area of basic bibliometric research. Traditionally, work in this area is supported by grants. Methodological research is conducted mainly in this area.

Bibliometrics for scientific disciplines. Scientists and researchers in various scientific disciplines form the largest but also the most diverse group in terms of interests in bibliometrics. In view of the main scientific orientation, their interests strictly correspond to the chosen specialty. This area can be considered an extension of informatics by metric means. There is also a boundary region of association with the quantitative analysis in information retrieval.

Bibliometrics for the management of science and science policy-making. Currently, the area of research evaluation is the most important one. In the foreground are the national and regional structure of science and their comparative analysis.

It is generally accepted that almost simultaneously with A. Pritchard, in 1969, V.V. Nalimov and Z.M. Mul'chenko proposed the term *naukometriya* (*scientometrics*) to refer to the development of quantitative methods for the study of science as an information process [14]. Note, however, that this term was used earlier in a paper by V.V. Nalimov [35] published in 1966.

A comprehensive methodological overview of the current state of scientometrics is given in a paper by L. Ivancheva [12]. The author singled out two main classes of indicators as objects of study in the scientometric study, i.e., "incoming" related to the research process, such as scientists, financial parameters, infrastructures and organizations, research programs, etc., and the "coming out," which are related to research products, such as implemented projects, recorded discoveries, patents, publications (or their components), as well as links to them.

The following research subjects occur in scientometrics:

(1) Scientometrics as such in the epistemological sense, viz., its overall system development, disciplinary structure and interactions, research frontal dynamics, etc.

(2) The creation of scientific knowledge, i.e., quantitative characteristics of scientific potential, communication in science, scientific productivity, evaluation of scientists and scientific institutions, scientific cooperation, structure of scientific communities and networks, etc.

(3) The macro environment of scientific research, viz., the research policy, innovation processes, globalization, etc.

Ivancheva [12] presented and clarified the classification proposed by W. Glänzel [9] according to which scientometrics is a multiaspect study of subareas such as:

(1) *Dynamic scientometrics*, which process information by the creation of comprehensive models of growth of scientific knowledge, aging of scientific information, development of citing processes, etc.

(2) *Structural scientometrics*, which corresponds mainly to the problem of "cognitive representation of the structure of scientific knowledge" based on techniques such as co-citation, bibliographic coupling, or co-word analysis.

(3) *Evaluative scientometrics* with the subject of evaluation in the field of scientific research and for the purpose of science policy.

(4) *Prognostic scientometrics*, which predicts the development of scientific processes in the future.

O.V. Vydrin [36] believes that scientometrics, in fact, is the application of principles of cybernetics to the study of the phenomenon of science. In this approach, processes of information exchange between scientists are considered on the basis of the communication scheme proposed by C.E. Shannon.

In 1979, the term *informetrics* (from the German *Informetrie*) almost simultaneously appeared in the works of O. Nacke, L. Blackert, and K. Siegel [37, 38]. Nacke [37] defined informetrics as the study of the application of mathematical methods to the objects of information science to describe and analyze their properties, establish laws, and perform decision making.

In 1985, M. Morales [39] came to the conclusion that there was a necessity for the development of an independent interdisciplinary science that could analyze and summarize metric aspects of other scientific disciplines on the basis of the theoretical applications of information science. He defined informetrics as a discipline that is responsible for studying mathematical and statistical methods and models and their application to the quantitative analysis of the structure and properties of scientific information and patterns of scientific communication process including the identification of these very patterns. According to Morales, informetrics examines the following aspects: (1) the quantitative growth of literature, (2) the aging and dispersion of information, (3) the effectiveness of information products and services in the field of production, science, and technology, (4) the effectiveness of the information system and information organs collectively, (5) the role of different types of documents as means of scientific communication, (6) the role of informal channels of scientific communication, (7) the relevance and pertinence of information, (8) the ranking of periodicals and continued editions on various aspects, (9) the thematic proximity of periodicals and continued editions, (10) the value of the citation practice between scientists and its development, and (11) intradisciplinary and interdisciplinary connections based on references.

In [1], V.I. Gor'kova indicated that it was necessary and timely to establish informetrics as a scientific field of information science on methods of measurement of properties, characteristics, and finding definitions of the objects of information science and subjects of information activities. The object of informetrics is defined as scientific information and scientific communication. Its subject is their objective quantitative principles that are used to improve information activities. In this case, scientific information and scientific communication refers not only to the scientific and technical literature, which is the input documentary information flow, but also the results of information activities, i.e., information arrays, natural and formal languages as a means of indexing and retrieval, information requests of consumers, i.e., users of information, and other objects of information activities.

In 1990, the Elsevier publishing house published perhaps one of the most well-known and cited textbooks on informetrics [10]. In fact, the subtitle is an implicit definition of informetrics, namely: "Introduction to Informetrics. Quantitative Methods in Library, Documentation, and Information Science." The authors, L. Egghe and R. Rousseau, defined informetrics as mathematical metainformation, i.e., as the information theory of information developed from the point of view of mathematical tools.

Obviously, advances in information and communication technologies and the creation of the Internet, which greatly expanded the range of problems that are studied by informetrics, had a significant influence on the development of informetrics.

B.C. Brookes in a speech at the Second International Conference on Bibliometrics, Scientometrics, and Informetrics, commented on the history of the origin and use of different terminology of metrics and proposed to take the fact into account that the information world in which these terms emerged has changed rapidly in recent years, "Modern technology has provided us with a new, nondocumentary form of submission, transfer, and diffusion of knowledge." However, he characterized informetrics as "the most generic term that embraces both the biblio- and scientometrics" [40].

According to a definition that J. Tague-Sutcliffe proposed in 1992 that is widely accepted in foreign papers [41] "informetrics is the study of quantitative aspects of information in any form, not just recorded or bibliographies, and in any social group, not just scientists." According to J. Tague-Sutcliffe, informetric studies cover not only the documentary forms of information but also include informal and oral communication. They do not depend on the form in which information is recorded and the way it is produced.

We agree with the authors of [42] who emphasize that "when the above definitions were proposed, the World Wide Web did not exist, but today it is rapidly becoming a major source of information. Informetrics methods can be applied to the Web and new techniques are developed for this environment." It is very important to understand the problems, peculiarities, and limitations of the new environment and tools for studying a new information space.

Since the mid-1990s for this rapidly developing field of research a number of new terms were proposed, for example, (1) *netometrics* (M.J. Bossy, 1995), (2) *webometry* (R.H. Abraham, 1996), (3) *internetometrics* (T.C. Almind and P. Ingwersen, 1996), (4) *webometrics* (T.C. Almind and P. Ingwersen, 1997), (6) *cybermetrics* (this is the title of the electronic journal published since 1997 by Isidro Aguillo), and (7) *Web bibliometry* (S. Chakrabarti, M.M. Joshi, K. Punera, and D.M. Pennock, 2002) [43].

In 1995 M.J. Bossy [44] used the term *netometrics* to describe scientific interaction via the Internet. She sees the Internet as the main source of data for studies of "science in action."

The term *webometrics* was introduced by T.C. Almind and P. Ingwersen [45] in 1997 on the assumption that informetric methods can be used to study the World Wide Web and network communications. In the early days of webometrics, links between web pages and quotes were seen as two sides of the same coin. Web pages are "entities of information on the Web with hyperlinks from them acting as citations" [45]. Today it is recognized that there are some differences between the hyperlinks and references related to the dynamic nature of web data.

In 2004, Björneborn and Ingwersen [43] proposed a differentiated terminology to distinguish between the Web research and research of all Internet applications. The term *cybermetrics* is used as a generic term for the study of quantitative aspects of the creation and use of information resources, structures, and technologies of the Internet as a whole promoting bibliometric and informetric approaches. The term *webometrics* as a subdomain of cybermetrics refers to the research area that examines the quantitative aspects of the creation and use of information resources, structures, and technologies on the World Wide Web. This definition covers the four main areas of webometric research:

(1) Content analysis of web pages.

(2) Analysis of the structure of links to the site.

(3) Web analysis of usage (for example, of log files to find and view information behavior of users).

(4) Web technology analysis (including the operation of search engines).

In 2009, Thelwall defined *webometrics* more broadly, i.e., as a study of online content, particularly by quantitative methods, for the sociological research using methods that are not specific for one area of research [46].

Numerous modern web studies are conducted mainly in two areas, i.e., link analysis and web citation analysis [46]. Currently, webometrics methods are widely used in different application contexts, such as in the preparation of webometric ranking of world universities.

In response to new web developments Björneborn in the report [47] introduced the term *webometrics 2.0*, which means the study of quantitative aspects of the creation, distribution, and use of resources, structures, and technologies of Web 2.0 promoting bibliometric and informetric approaches. He identifies such branches of webometrics 2.0, such as *blogometrics*, *wikimetrics*, etc.

Later, J. Priem and B.H. Hemminger [48] used the term *scientometrics 2.0*.

In addition, the use of terms such as *historical bibliometrics* [49], *educational scientometrics* [50], and others can also be found in publications.

L. Egghe [51] noted that currently the rapid growth and expansion of multidisciplinary research in the field of informetrics is occurring, mainly because of new topics such as quantitative research of networks including the Internet, intranet, and other social networks, as well as the creation of an information society.

In [52], Egghe highlights the following aspects of the informetric Internet research. First of all, it is an increasing problem of collecting data in an electronic environment. The second theme is associated with online versions of informetric laws. The question arises of whether classical distributions are of the same kind. The next theme is related to aspects of scientometrics, i.e., whether hyperlinks on web pages can replace classical references in scientific papers. This includes research on the WIF (Web Impact Factor) and the discussion of aging of electronic information. The fourth theme affects the information retrieval (IR) in search engines, namely: the probabilistic aspects of IR and quantitative assessment of IR.

The next important theme is associated with the use and access to papers in digital libraries. Most papers currently are published in electronic journals and/or repositories, which offer new opportunities for measuring the use of new papers not only by quotations or webquotations but by the number of downloads. According to Egghe, downloads can be considered as electronic versions of reading or photocopying of the paper version [51].

According to D. Wolfram [53], within information science there are two main areas of research, i.e., information retrieval and informetrics. Accordingly, in informetrics two aspects can be singled out, which are related to the content of information retrieval systems and their use.

Glänzel [9] considers informetrics as a field of information science related to the mathematical-statistical analysis of communication processes in science and highlights the areas of research, such as statistical analysis of (scientific) text and hypertext systems, library circulations, measurement of information in digital libraries, models of Information Production Processes, and quantitative aspects of information retrieval.

W.G. Stock and S. Weber [54] analyzed and synthesized various definitions and came to the conclusion that informetrics includes all quantitative research in information science and named the following subject areas in which such research take place:

(1) The information itself including general (descriptive and normative informetrics), special (scientometrics, patentometrics, news informetrics, etc.), and web information (webometrics, blogometrics, etc.).

(2) Information users and information usage.

(3) Information systems (evaluation of retrieval, functionality, performance, etc.).

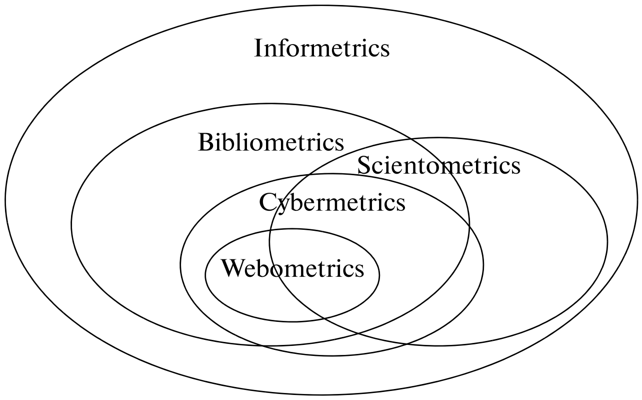
RELATIONSHIPS BETWEEN METRICS

Wilson [23] notes that traditionally informetrics is defined by the enumeration of its subdomains.

The Chief Editor of *Journal of Informetrics* Egghe [51] defines the term *informetrics* as a broad term that includes all metric research related to information science including bibliometrics (bibliographies, libraries, ...), scientometrics (science policy, citation analysis, research evaluation, ...), webometrics (metrics of the web, the Internet, or other social networks, such as networks of citation or collaboration), ...

The relationship of the considered concepts is clearly shown in the diagram (see figure) in [43].

We emphasize that in the opinion of some scholars (see, e.g., Glänzel [9], Ravichandra [55], etc.) the terms "bibliometrics" and "scientometrics" are used



The relationships between the subdomains of informetrics [43].

almost interchangeably. On the other hand, some experts refuse to consider scientometrics as a part of informetrics. This is one of the reasons that led to the modern name of the International Society for Scientometrics and Informetrics (ISSI), which was founded in 1993 in Berlin during the fourth International Conference on Scientometrics and Informetrics [23, 56].

ALTMETRICS

The creation of the World Wide Web has given rise to new forms of scientific discourse. Web 2.0 tools provide researchers even faster and less formal ways of communicating within and outside the scientific community. In recent years, a growing number of scientists use social media such as Twitter, Facebook, CiteULike, Mendeley, etc., in their professional communication.

The online and publicly available nature of social media represents and embodies the processes of scientific communication, especially the ones thar are hidden and ephemeral [57]. Comments on papers in the style of a blog provide the ability to track the impacts of new scientific methods. According to [58, 59], metrics based on a diverse set of websources complement traditional metrics based on citations and can lead to a more diverse and timely assessments of current and potential scientific impacts.

This new line of research has been called *altmetrics* (*alternative metrics*). It is understood as the creation and study of new metrics for the analysis of scientific communication (the scientific impact and communication behavior of scientists) outside the traditional channels of scientific communication system, namely, in social networks, blogs, forums, etc. [59].

The main areas of research in the field of altmetrics are associated with such topics as (1) the rationale for metrics based on the use of social networks, (2) their advantages and disadvantages, (3) monitoring of scientific communication in social networks, (4) the relationship (correlation) of traditional metrics and altmetrics, (5) peer review and altmetrics, (6) tools for data collection, (7) and analysis and dissemination of altmetrics.

THE CONCEPT OF THE PRODUCTION INFORMATION PROCESS

The basic properties of information are shown in information processes. In the last quarter of the 20th century, as a result of extensive research into the underlying patterns and methods of implementation of information processes in various complex systems, including processes of information exchange, scientists indicated the commonality of information processes in technical systems, as well as in nature and society. To date, the idea of a community of information processes in the world around us is accepted by the majority of scientists. As noted in [60], this concept represents a scientific confirmation of the universality of the nature of information.

In order to explain statistically common patterns of information processes and phenomena, Egghe proposed the concept of the *Information Production Process* (IPP) [10]. According to this concept, the main object of the informetric research is the two-dimensional information production process, in which there are two kinds of objects, i.e., *sources* that produce (e.g., journals, authors, and keywords ...) and *products* that are made by these sources (respectively, for example, papers, publications, and words in texts ...), as well as a function that describes the relationship between sources and products.

A bibliography of papers on a particular topic published in various journals can serve as a classic example of the IPP. In this case, journals can be viewed as the sources that “manufacture” products, i.e., papers. Based on this example one can draw other relationships. For example, if the author appears as a source then the product is their publication, i.e., the relationship “author “produces” publication" is considered. In turn, the paper (which is the product in the previous examples) can act as the source that “produces,” for example, links or citations as products.

There are examples of the IPP beyond informetrics, i.e., in other areas of knowledge, for example, texts in linguistics (words are the sources and their use in the text (characters) is products), library (books are sources and delivery of books is the product), econometrics (employees and their work are the sources and productivity is the product), demography (towns and villages are the sources, and their residents are the product), etc.

These examples correspond to the so-called *two-dimensional informetrics* in which it is easy to state and prove the equivalence under certain conditions of the basic informetric laws of Lotka, Bradford, Zipf, Mandelbrot, Leimkuhler, etc.

In addition, Egghe highlights *three-dimensional informetrics* (*type/token-taken informetrics*), which addresses not only the sources and products but also the use of products [61]. For example, a journal “produces" papers, and the papers "produce" (receive) citations. Thus, the final process is that the journal receives citations, i.e., the overall citation of the journal is examined.

The possibility to describe different informetric laws on the basis of one and the same Lotka function led Egghe to the concept of the so-called *Lotkaian informetrics* [62].

CONCLUSIONS

Thus, over the past decades an improvement has occurred in the range of research tasks of informetrics from librarianship to information science and beyond, from the study of documents on paper to the study of the information in any medium and in a network, from bibliographic data analysis to the analysis of full-text documents and webdata, etc.

Today informetrics is a dynamically developing interdisciplinary research area that quickly reacts to any especial technological change. Among the latest innovations, we note the emergence of a new field of research, i.e., alternative metrics. Experts associate the future of informetrics mainly with the development of intelligent data analysis, mapping, and visualization of areas of knowledge, as well as with the development of multidimensional dynamic models of scientific and social communication.

Following Wilson [23], we end the article with several questions. Will the concept of *knowledge* replace the concept of *information*? Will the concept of *informetrics* turn into *epistometrics* (a form of *epistemology*)? What are the limits of informetrics? What is the relationship between informetrics and other sciences that provide quantitative methods for the study of objects of a different nature? Can they be combined into one macrodiscipline, for example, *datametrics*, as suggested in [63]? Finding the answers to these questions offers ample opportunities for future research.

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