Tools and methods for Science outputs evaluation

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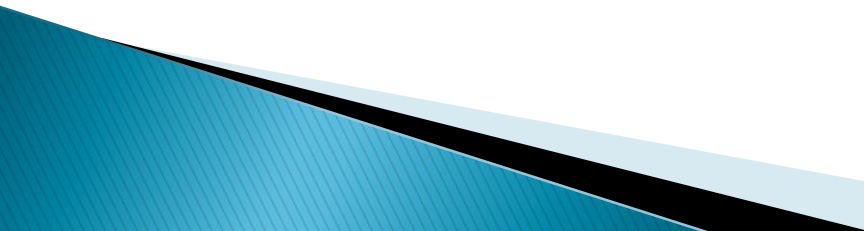**Visiting Scientist DRTC Indian Statistical Institute, Bangalore**

Formerly Professor & Chairman Dean Faculty of Social sciences

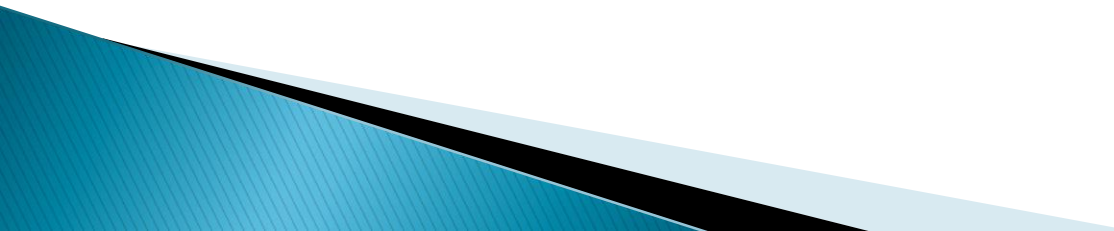Department of Library and Information Science

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Introduction

- Scientific research produces new knowledge. The essence of scholarship is communication.
- Some fraction of which can lead to enormous returns.
- Good science leads to novel ideas and changes the way
- Good science influences the direction of science itself,
- and the development of new technologies and social policies.
- Poor science leads to dead ends, either because it fails to advance.
- Perhaps the most important requirement of a good measure of scientific output is quantitative evaluation(Statistical tools & methods).
- But suffers from some important limitations.

Introduction

- Statistics is a "Key technology" – as it is required for all socio-economic developmental activities. Statistical techniques are used in all developmental and Science output evaluation and forecasting studies.
- In recent past, statistics has been applied to a number of areas such as perspective planning, industrial and agricultural development, etc.
- Library and Information managers have adopted a number of quantitative methods in recent years in order to evaluate Scientific productivity, library resources and services more objectively and effectively.
- Scientometrics/ Informetrics refer to quantitative techniques applicable to measure the records of human communication. Over the years, several new terms have appeared on the horizon representing quantitative studies in library and Information Science.

Librametry

> In 1948 at the Aslib's conference in Lamington Spa, Ranganathan introduced the term Librametry for the first time. He suggested to develop librametry on the lines of biometry, econometry, and psychometry .

> The term Librametrics has two roots: Libra and Metry. The word 'Libra' connotes 'library' and 'metrics' means measurement.

> We can define Librametrics as a Quantitative analysis of various facets of Library activities; and library documents by application of mathematical and statistical calculus to seek solution to library problems.

1. Organization of library system.
2. Design of library building, fittings, and furniture.
3. Collection development.
4. Absolute syntax and facet syntax in relation to classification. Evaluation of Resources etc.

Bibliometrics

- The term bibliometrics was first coined by Prichard (25) in 1969 in preference to existing terminology 'statistical bibliography'. The word "Bibliometrics" has two roots: 'biblio' and 'metrics.

Meaning and Definition

- The term 'biblio' is derived from the combination of Latin and Greek word 'biblion' equivalent to Bylos, meaning book, paper which in turn was derived from the word Bylos, a city of Phenonicia, a noted city for export trade in paper,metrics means measuring.

- **Bibliometrics** is the quantitative analysis of research literature, based upon citations, and can be used to evaluate the impact on the academic community of a research paper, an individual researcher, a research group or institution, or a journal.

Scientometrics

- In the 1960s, particularly in Eastern Europe, the term "scientometrics" was used to denote "measurement of informatics process."

Meaning and Definition

- The term informatics was then widely used to mean "documentation / information handling activities;" obviously, there is not much difference between bibliometrics of the West and the scientometrics of the East Europe.

- The term Scientometrics originated as a Russian term for the application of quantitative methods to the history of science, which studies the quantative aspects of science.

Application of Scientometrics

- Scientometrics is concerned with the quantitative features and characteristics of science and scientific research. Emphasis is placed on investigations in which the development and mechanism of science are studied by statistical mathematical methods.
- Scientometrics is now considered as a part of the sociology of science and is applied to science policy making. Thus Scientometrics involves studies in:
- Sociology of Science,
- History of science,
- Growth of literature
- Behaviour of scientists,
- Science indicators, etc.

Informetrics

➢ Information is any kind of event that affects the states of a dynamic system.

Meaning and Definition

➢ The English word was apparently derived from the Latin stem (*information-*) of the nominative (*information*): this noun is in its turn derived from the verb "informare" (to inform) in the sense of "to give form to the mind", "to discipline", "instruct", "teach":

➢ Metrics means measuring. Informetrics is the study of quantitative aspects of information.

➢ This includes the production, dissemination and use of all forms of information, regardless of its form or origin.

Application of Informetrics

- The application of a informetrics study may be used for variety of measures to study and analyse several properties of information in general and documents in particular the study of the quantitative aspects of information in any form, not just records or bibliographies.
- Informetrics is the study of quantitative aspects of information.
- This includes the production, dissemination and use of all forms of information, regardless of its form or origin.
- As such, informetrics encompasses the fields of which studies quantitative aspects of science.
- It is mostly concerned with development of models to explain and identify the various characteristics of the literature. It also discusses scientific productivity, collaborative research, etc.
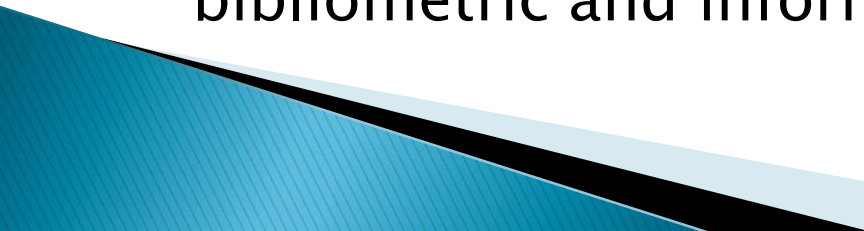
Webometrics

- The science of webometrics (also cybermetrics) tries to measure the World Wide Web to get knowledge about the number and types of hyperlinks, structure of the World Wide Web and usage patterns.

Meaning and Definition

- According to Björneborn and Ingwersen, the definition of webometrics is "the study of the quantitative aspects of the construction and use of information resources, structures and technologies on the Web drawing on bibliometric and informetric approaches." The term *webometrics* was first coined by Almind and Ingwersen (1).

- A second definition of webometrics has also been introduced, "the study of web-based content with primarily quantitative methods for social science research goals using techniques that are not specific to one field of study" which emphasizes the development of applied methods for use in the wider social sciences.

Cont..

- Cybermetrics is one of the recently emerged fields in the line of metric studies. It has gained much popularity since the mid-1990 with the advent of Information Technology.

- As it is mainly concerned with the computer-science-based approaches, it has superseded all other metric studies in this Internet Era.

- Cybermetrics is proposed as a generic term for "The study of the quantitative aspects of the construction and use of information resources, structures and technologies on the whole Internet drawing on bibliometric and informetric approaches."
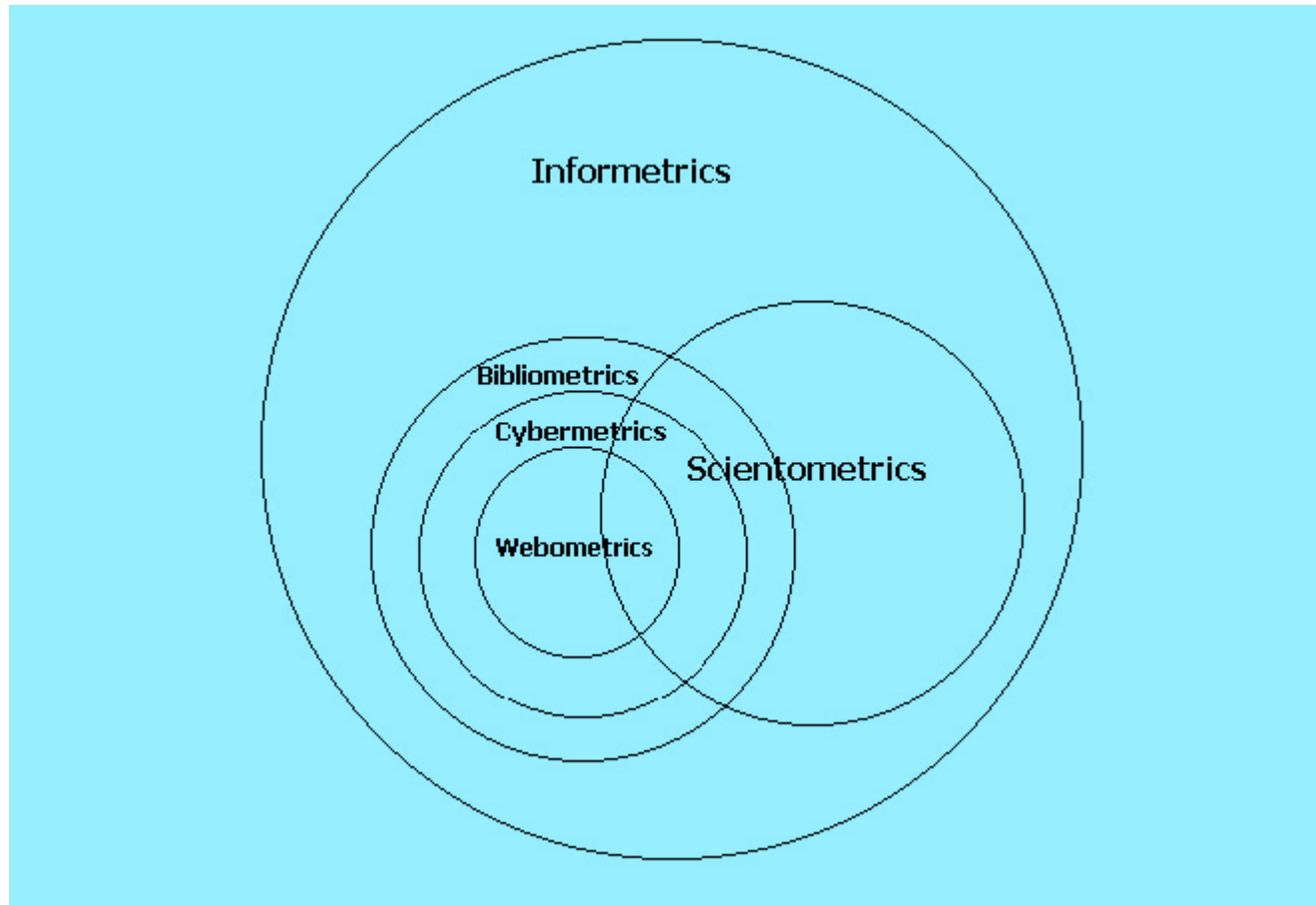
Scope of Webometrics

▸ The study of the quantitative aspects of the construction and use of information resources, structures and technologies on the whole Internet drawing on bibliometric and informetric approaches."

▸ Cybermetrics thus encompasses statistical studies of discussion groups, mailing lists, and other computer – mediated communication on the internet, including the www.

▸ Besides covering all computer-mediated communication by using internet applications, this definition of cybermetrics also covers quantitative measures of the internet backbone technology, topology and traffic.
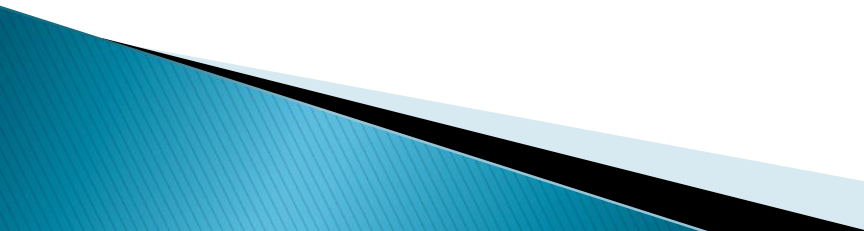
Figure-1

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- As shown in the diagram fig.1, the field of cybermetrics exceeds the boundaries of bibliometrics, because some activities in cyberspace normally are not recorded, but communicated synchronously like in chat rooms.
- Cybermetric studies of such activities still fit in the generic field of Informetrics as the study of the quantitative aspects of information "in any form" and 'in any social group" as stated by Tague-Sutcliffe (1992).
- The inclusion of webometrics expands the field of bibliometrics, as webometrics inevitably will contribute with further methodological developments of web-specific approaches.
- As ideas rooted in bibliometrics, scientometrics and Informetrics contributed to the emergence of webometrics, ideas in webometrics might contribute to the development of these embracing fields.

Altmetrics

- "Alternative metrics" or "altmetrics" refers to different ways of measuring the use of, and impact of, scholarship. Rather than solely measuring the number of times a work is cited in scholarly literature, altmetrics aims to capture a more complete picture of scholarly impact by counting and analyzing the usage of more recent avenues of scholarly communication:
- Views and downloads from online repositories and databases
- Sharing through social media (for example, Facebook and Twitter)
- Citations and discussions in blogs and wikis
- Social bookmarking (for example, Delicious and CiteULike)
- Mentions and comment counts (for example, in Reddit and YouTube)
- Holdings in library collections

Altmetrics

- Additionally, altmetrics can be used to understand the research impact of scholarly works that aren't traditionally captured through citation counts, such as
- Figures and images
- Reports
- Data sets
- Books and book chapters
- Proceedings
- Presentations and slides

Knowledgometrics

- Knowledge metrology is an interdisciplinary integrated research topic.
- Knowledge Metrology is the scientific evaluation of Wuhan University, China Research centre in bibliometrics, information metrology, scientific metrology, network metrology etc.
- It studies the whole human knowledge system as research object, and study the social ability of knowledge, and the social relationship of knowledge through the quantitative analysis.

Empirical Laws of Bibliometrics

- The Bradford's Law of scattering.
- Lotka's Law– describes the frequency of publication by authors.
- Zipf's Law– helps measure the richness of vocabulary of an author.
- These three basic laws of bibliometrics,' and each of these distributions was empirically derived.
- The distributions are similar to each other as special cases of a hyperbolic distribution.
- Empirical laws are:

1. derived from experience or experiment,

2. depending upon experience or observation alone, without using scientific method or theory, and having limitations.

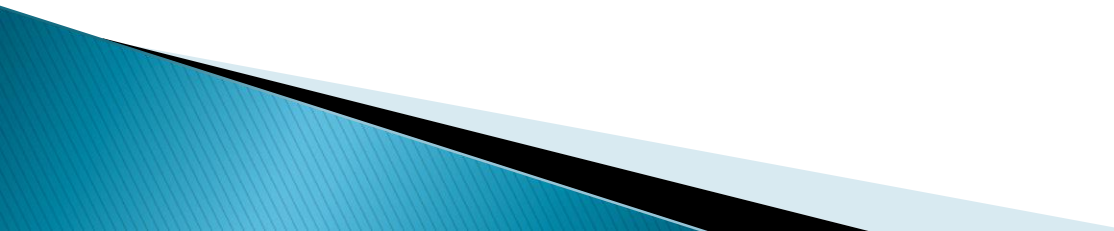3. verifiable by experience or experiment

Imfact factor of Journal

- Garfield's (ISI) contribution: Impact Factor is the measure of the frequency with which the 'average article' in a journal has been cited in a particular year all period.
- Researchers believe that more the **impact factor**, better the research work is.
- The Impact Factor is generally calculated on the basis of a 3 year period. For example, the 2007 Impact factor for a journal would be calculated as follows:

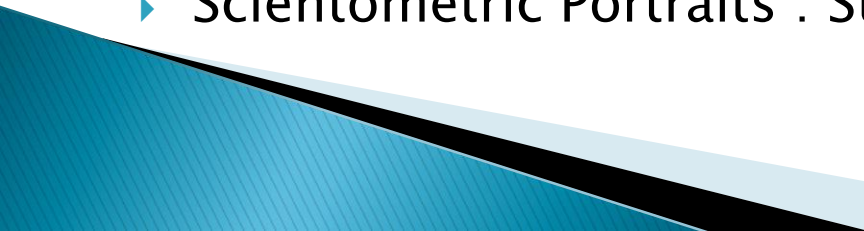A = Number of times articles published in 2005-06 were cited in tracked journals during 2007

B = Number of articles published in 2005-06

2007 Impact Factor = A/B

H-index

- Hirsch (2005) proposes a scalar index, an original simple new indicator to characterize the cumulative impact of the research work of individual scientists.

- It is the highest number of publications of the scientists that received 'h' or more citations.

- Currently the h index is used to measure research output not only of scientists but also research groups, scientific facilities, university, institute and countries.

Other tools and methods

- Citation analysis
- Growth models and Doubling time: exponential, linear and logistic are applied to access the growth.
- Obsolescence studies.
- Collaboration
- Activity Index –It implies the relative research effort of a country devotes to a given subject field.
- Priority Index –
- Ranking of Universities/Institutions.
- Mapping of science: Visual representation of an area, an outline of distribution of knowledge at different levels.
- Science & Technology Indicators.
- Scientometric Portraits : Study of individual scientist.

Softwares for evaluation

- **Bibexcel**: is a great tool for helping with bibliometric analysis, and citation studies in particular.

- **CiteSpace II**: Detecting and Visualizing Emerging Trends and Transient Patterns in Scientific Literature.

- **CoPalRed** ' from publication 'Mapping and Visualization Softwares tools: a review' on ResearchGate.

- **INSPIRE:** *innovation in Science Pursuit for Inspired Research is an innovative programme sponsored and managed by the Department of Science & Technology for attraction of talent to Science.*

- The Science of Science (**Sci2**) **Tool** is a modular toolset specifically designed for the study of science.

- **OSviewer** is a software tool for constructing and visualizing bibliometric networks.

Cont…

- **Eigen Factor Score:**The impact **factor** was the brainchild of bibliographer **Eugene** Garfield … Journal, Impact**Factor** rank (**score**)
- **HistCite** is a software developed to allow the users to aid researchers in visualizing the results of literature searches in the Web of Science. By Garfield.
- **Pajek** is a program package for analysis and visualization of large networks (networks containing up to one billion of vertices.
- **Publish or Perish**, free and safe download. **Publish or Perish** latest version: A Free Software utilities program for Windows. **Publish or Perish** is an amazing, free …
- **Scholarometer** is a social tool for citation analysis, which provides a service to scholars by computing citation-based impact measures.

Conclusion

The fact, whether we call our research area as librametry or bibliometrics or scientometrics or informetrics most of the topics we deal with are:

- Quantitative aspects of library and information studies, especially use and user studies, growth of collection, age distribution of documents, circulation statistics, etc.
- Journal productivity (by coverage, by use, by citation, cost-effectiveness measures, impact factor, h-index, sources of citations, immediacy of citations, age of sources cited, coverage in databases, etc.)
- Measures growth of literature, productivity or author productivity, including studies related to multiple authorship (number of publications. cost-effectiveness measures, impact factor, h-index, reprints request, photo copies made, sources of citations, immediacy of citations, number of reviews, adoption rates (text books), etc.)