

# Bibliometric Visualisation of Computer Science and COVID-19: A Review and Proposed Method

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**Abstract**—The pandemic of COVID-19 has accelerated significantly, generating great concern throughout the world. As a result, the quantity of articles and journals published on COVID-19 has rapidly increase. However, these publications do not cover bibliometric visualisation sufficiently, particularly in the computer science field. Thus, the purpose of this article is to conduct a brief content review of the websites that offer bibliographic visualisation about COVID-19. Additionally, we propose a new framework for visually representing bibliometric data pertaining to computer science research and COVID-19. We believe that our method for bibliometric visualisation will benefit future research by serving as a guide. It will serve as a way for conducting COVID-19 bibliometric visualisation, in other areas, not limited to the field of computer science.

**Keywords**—COVID-19, Bibliometrics, SARS-CoV-2, Pandemic, Human-computer interaction, Data visualization

## I. INTRODUCTION

Since its fatal discovery in December 2019, the COVID-19 pandemic has developed into a serious concern. Since then, the rate of COVID-19 cases has skyrocketed, raising considerable fear throughout the world. Not only has it impacted the health industry, but also the education sector [1]. As a result, countries throughout the world have spent significant time and money to combating the pandemic [2].

Bibliometric visualisation is defined as a tool for determining the publication trends of a topic of study. It can identify the quantitative and qualitative information of research output [3]. The study of bibliometrics has grown in popularity as a method for evaluating worldwide research collaboration. Visualization approaches for scientific publication are also valuable for identifying publication trends across disciplines, not just for computer-related areas. This is particularly true in the present period, when thousands of unreferenced articles can be quickly uploaded and distributed to online pre-print archives [4].

Simultaneously, thousands of academic articles on COVID-19 have been published in a variety of scholarly journals. The number of publications published on COVID-19 has risen considerably in the aftermath of the outbreak [5]. However, as far as we are aware, no bibliometric analysis of the relationship between computer science and COVID-19 has been done. Some of the bibliometric analyses in the field of computer science did not cover COVID-19 research [6]. While bibliometric visualisation studies have been undertaken, there is an absence of bibliometric study on the connection between computer science and COVID-19 [7].

While some study has been conducted on COVID-19, there are currently only a few websites devoted to exhibiting the COVID-19 bibliometrics visualisation mapping. By having COVID-19 bibliometric data for computer science

articles on one website, it establishes a credible information source for researchers, clinicians, and the public. The purpose of this article is twofold:

1. To conduct a content analysis and visualisation of four websites focused to COVID-19 bibliometric visualization and analysis.
2. To propose a method for visually representing bibliometric data pertaining to computer science research and COVID-19.

Additionally, the framework for bibliometric visualisation mapping described in this research will include methods for visualising bibliometric data that are not limited to the field of computer science. This paper examines the technical elements of bibliometric mapping using a framework developed from [8] and [9]. This initiative will serve as a vital resource for researchers, scientists, and physicians seeking precise information regarding COVID-19 bibliometric data in the field of computer science.

## II. LITERATURE REVIEW

### A. The importance of data visualization

The term ‘visualisation’ describes the process of graphically representing facts and information. Data visualisation makes use of trends and patterns in data to aid in the acquisition of necessary knowledge. It contributes to the creation of a more complete picture and enhances our comprehension. Data visualisation enables the exploration of data via interactive charts, infographics, and maps. Data visualisation is crucial for effectively communicating a message and presenting pertinent facts. Data visualisation enables us to get insights from huge amounts of data in the age of big data [10]. Table I summarises the significance of data visualisation as stated by many authors.

TABLE I. The importance of data visualization

Authors	The importance of data visualization
[11]	Graphically displays meaningful information about variables contained in tabular data.
[12]	It helps the viewer to observe and comprehend the underlying structure of a dataset.
[13]	Assists in avoiding misrepresentation in information communication.
[14]	Contribute to the dissemination of an informational, compelling, and artistic message.

### B. Bibliometrics analysis

Bibliometrics analysis can be used to ascertain the general direction of a field of research, as well as to view qualitative and quantitative data on its publications [3]. Bibliographic data are handled in a workflow that encompasses study design, data collection, analysis, visualisation, and interpretation. [15]. As a result, bibliometric analysis has evolved into a

valuable tool for displaying and summarising the publication's history, trends, and future. Additionally, the advancement of scientific bibliometric analysis benefits classification and analysis of the expanding volume of publications. The rapid expansion of bibliometrics tools looks to be significant. Authors, institutions, location, publishers, and keywords can all influence the bibliometric network.

VOSviewer is a widely used tool for analysing publication networks. Clustering, mapping, and visualisation of bibliographic data are all capabilities of this software [16]. This software is a publicly downloadable tool designed to assist in the creation of bibliometric maps. Like any other majority of software products used for bibliographic mapping, VOSviewer displays bibliographic maps graphically. VOSviewer's feature is advantageous for visualising vast amounts of bibliometric data in a straightforward manner.

Additionally, bibliometric analysis can aid in determining current trends in the study literature and provide direction and incentive for future research [17]. The approach of bibliometric analysis can establish the publication pattern in certain disciplines. It enables the mapping of research topics and trends to be more effective.

In doing bibliometric analysis, bibliographic coupling, co-occurrence, and network analysis are often utilised techniques [18]. A network map can be used to depict the co-occurrence of terms [19]. Keyword co-occurrence network is a concept that refers to frequency of occurrence, and vicinity of comparable keywords. Co-occurrences comprise keywords that are connected to one another and are based on the same concept but are not identical. Fig. 1 illustrates a network depiction of keyword co-occurrences.

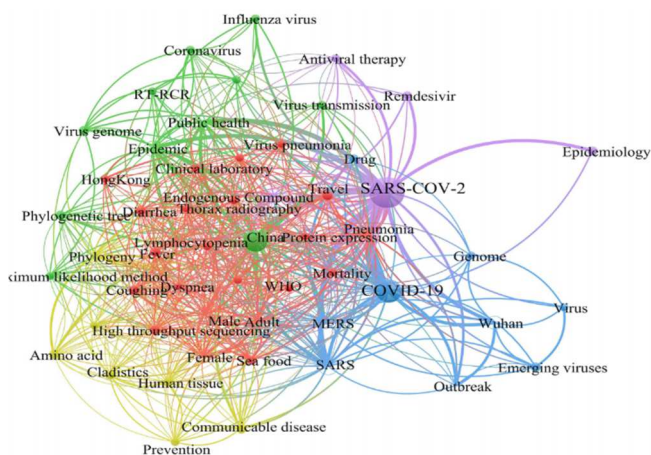


Fig. 1. Keyword co-occurrence network visualization [20]

### C. Bibliometric visualizations

Bibliometric visualisation strives to visually present the overview of bibliometric information and data. It is explorable and may generate valuable insights [21]. Following that, the bibliometric mapping findings can be analysed further [22]. VOSviewer can create network maps due to its ability to handle bibliometric data for over 5,000 journals [23]. This software allows the creation of network maps of co-citations, co-authorship, and co-occurrences. Additionally, zooming, navigation, and searching capabilities provide a more in-depth investigation of the map [24],[25]. Fig. 2 illustrates a visualization map of co-authorship network.

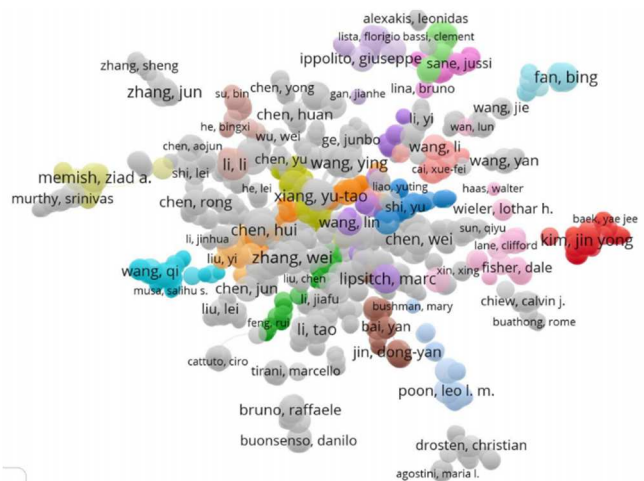


Fig. 2. Network visualization of co-authorship [26]

The network visualisation of co-authorship depicts the relationships between the authors' names or affiliations. Collaboration between authors can take numerous forms, including cross university and inter-country collaboration. Additionally, the publications should be analysed further to verify they adhere to their study's objectives [27]. Thematic analysis of database publications can be used to create a map based on the co-occurrence of phrases in the titles, abstracts, and keywords of the articles [3]. Further analysis of the records can be used to construct a network of publication collaboration between countries and organisations to discover the most outstanding countries and organisations, as well as their citation links [28],[29]. Researchers typically take publication records from Web of Science and Scopus to ascertain the international pattern of collaboration [30]. Fig. 3 illustrates how VOSviewer can be used to visualize the most collaborative countries.

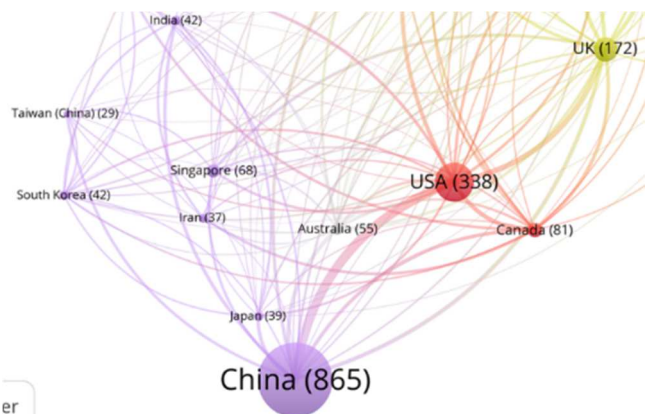


Fig. 3. International collaboration of most-collaborative countries (cropped) [30]

## III. REVIEW OF COVID-19 BIBLIOMETRIC VISUALIZATION

Through a survey of the next four websites, many pieces of information and visual maps can be gathered. Their contributions would aid academics in assessing the state of bibliometric research in this field. This would also assist scholars in finding and investigating potential for international collaboration. This would also assist researchers in identifying appropriate journals for publishing bibliometric work more quickly.

### A. COVID-19 bibliometric

COVID-19 Bibliometrics is a website developed by the University of Malaya. It aims to provide accurate information on the current development of the pandemic by analysing published articles related to COVID-19. The website can be visited via [www.covid19bibliometrics.org](http://www.covid19bibliometrics.org). Fig. 4 shows the visualization of keyword occurrences network visualization on covid-19 publications produced by the website.

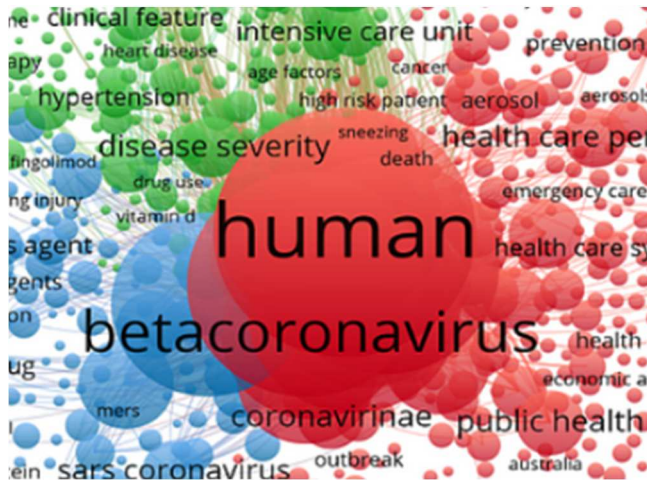


Fig. 4. Keyword occurrences network on covid-19 publications (cropped)

The user is guided to four categories by clicking on the 'Research Insights' tab: 'Medicine and Health', 'Science and Engineering', 'Social Science, Humanities, and Public Policy', and 'Gaps in Research'. This capability enables easier access to any research that has been conducted and published. The offered content is dated 2020 and is organised by month. However, one drawback of this site is that it does not include bibliometric analysis of COVID-19 papers in the field of Computer Science.

### B. COVID-19 social science lab (Biometric)

This website was created by University of Ljubljana, Slovenia to provide the information on COVID-19 in areas that have received less attention, such as the pandemic's socioeconomic implications. One can access the webpage at [www.covidsoclab.org/bibliometrics](http://www.covidsoclab.org/bibliometrics). It is organised around four primary sections: 'Bibliometrics,' 'Global Student Survey,' 'Public Administration Survey,' and 'Government Responses.' Fig. 5 is a word cloud containing information about COVID-19 research that is accessible from the site.

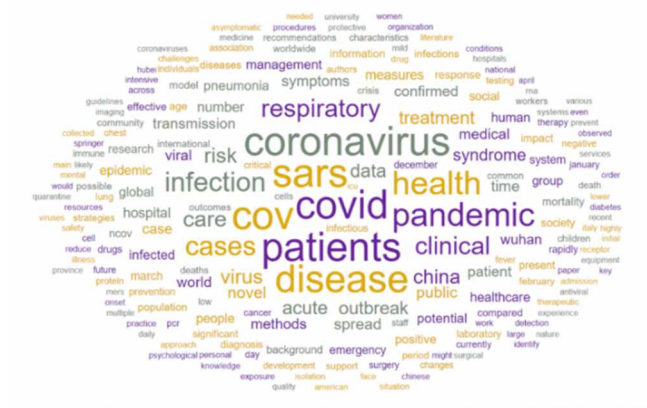


Fig. 5. Word cloud on covid-19 research

### C. MHADRI

Migration Health and Development Research Initiative (MHADRI) under Migration Health Division (MHD) built this website for information dissemination about the research they conducted. It includes the information about their findings about COVID-19 with their stakeholders. MHADRI's website is available at [www.mhadri.org](http://www.mhadri.org). COVID-19's bibliometric analysis in the context of migration health is depicted in Fig. 6.



Fig. 6. MHADRI bibliometric page

### D. Collabovid

Collabovid is a German Federal Ministry of Education and Research initiative ([www.collabovid.org](http://www.collabovid.org)). Using natural language processing, this website was built to assist in identifying materials surrounding COVID-19 in Germany. Users can do a literature survey to locate pertinent journal articles and fresh research papers. Furthermore, they can use the filter to perform an elaborate their search for authors, journal titles, categories, themes, places, publishing dates, and paper types. The website is divided into several sections, including general, mechanism, transmission, diagnosis, treatment, prevention, case report, as well as epidemic forecasting. Additionally, the dots on the map indicate the locations of articles published related to COVID-19. Publications are presented in three-dimensional space on the visualisation page. Similar works are grouped together based on similar topic matter. The purpose of the visualisation page is to provide useful insight into evolving issues and to direct users to related publications. Fig. 7 illustrates the visualisation page.



Fig. 7. Visualization page

The comparison of above-mentioned bibliometric visualization website related to COVID-19 is shown in Table II.

TABLE II. Comparison of related COVID-19 bibliometric visualization websites

Features	COVID-19 Bibliometrics	COVID-19 Social Science Lab (Bibliometric)	MHADRI Bibliometric Project	Collabovid
Provider/owner	University of Malaya, Malaysia	University of Ljubljana, Slovenia	Migration Health Division (MHD)	Federal Ministry of Education and Research, Germany
Bibliometric analysis tool used	VOSviewer	Did not mention	VOSviewer	Did not mention
Visualization dimension	2D	2D	2D	3D
Interactive visualization	N	N	N	Y
Word cloud visualization	N	Y	N	Y
Keyword co-occurrence network mapping	Y	N	Y	N
Focused on Computer Science publication?	N	N	N	N

#### IV. PROPOSED METHOD

We present in this article a method framework for performing a complete bibliometric study of computer science research connected to COVID-19. No such investigation has ever been undertaken to our knowledge. The procedure can be broken down into four distinct parts. Fig. 8 illustrates our proposed framework for bibliometric visualisation. We will explain it further in the following subsections:

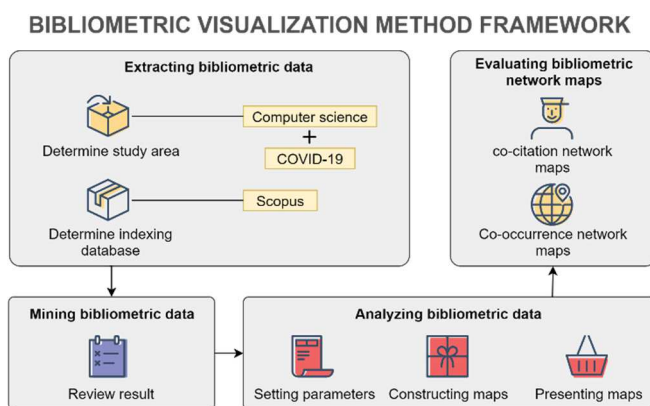


Fig. 8. Bibliometric visualization method framework (adapted from [8] and [9])

##### A. Extracting bibliometric data

In this step, the area study and the indexing database to be used will be determined. We identified computer science as the field of the study. We aim to find computer science journal articles related to COVID-19. We will use Scopus as the indexing database to retrieve the bibliometric data.

##### B. Mining bibliometric data

The following stage will be to mine the bibliographic data. Data mining is a vital step in the process of generating relevant bibliometric discoveries. Data mining is the most fundamental and critical step toward obtaining useful and reputable research results. Our analysis will cover all related publications between 2020 and 2021. This step includes establishing the search terms and criteria, analysing the results, deleting redundancy, and exporting the findings. We will obtain bibliographic information from the Scopus database. The approaches for mining bibliometric data are summarised in Table III.

TABLE III. Methods for mining of bibliometric data

Methods	Scopus
<b>Define the keywords</b>	Covid-19, Coronavirus, Computer Science
<b>Define search criteria</b>	Topic: COVID-19 AND Computer Science Publication period: 2020 until 2021 Document type: Article Language: English
<b>Review the results</b> (Title, abstract, keywords)	Reviewing the articles based on titles, abstract and keywords.
<b>Eliminates duplication</b>	Eliminates the articles that are duplicated and irrelevant to the topic
<b>Export the results</b>	Exporting the results after filtering out the irrelevant and incomplete records

##### C. Analysing bibliometric data

###### 1) Setting bibliometric parameters

The analysis will be performed step by step which are determining the field of study, determining database used, mining of bibliometric data, analysis of bibliometric data, and grouping of analysis of trends. The bibliometric parameters that will be analysed in this study using SCOPUS are year of publication, the type of document, journals, country or institutional origin, authors, number of citations, and research methods used. A parameter called kernel width will be involved in the density view and cluster density view of the bibliometric map [23]. This study will focus on COVID-19 articles in Computer Science, using the keywords 'COVID-19' OR 'Coronavirus' AND 'Computer Science'. The search criteria will be limited to English language papers published from 2020 until 2021, the subject area will be Computer Science. The document type is limited to article. The bibliometric parameters that will be analysed in this study are year of publication, the type of document, journals, country or institutional origin, and number of citations.

###### 2) Constructing maps

The CSV exported from SCOPUS will be opened in VOSviewer to construct the maps. This step constructs visual maps of the objects of interest using the bibliometric mapping technique VOS-mapping (Visualization of Similarities). It creates a more suitable map than techniques based on multidimensional scaling or hierarchical clustering mapping.

###### 3) Presenting maps

By displaying bibliometric mapping in a suitable visualisation manner, the value of the data can be considerably boosted. For example, the scale of a node can be adjusted to convey information about its relative importance. Colours can be used to distinguish various types of items, and labelling can be displayed clearly to avoid

overlapping. Additionally, VOSviewer's year-slider feature enables interactive study of the maps.

#### D. Evaluating bibliometric network maps

Finally, the bibliometric network maps will be evaluated. The maps obtained will be evaluated by the type of maps, colours of nodes, the size of the nodes, and the number of links. Due to the study's primary focus on the applied elements of bibliometric mapping, no specific attention will be paid to the process's technical evaluation [9]. The co-citation network map and the co-occurrence network map are the two primary bibliometric map types that we shall build. Apart from using standard graphs for descriptive data analysis, we will develop a mapping visualisation for these data:

1. Main topics (from the topmost productive institutions).
2. Journal co-citation network.
3. Author co-citation network.
4. Author-keywords co-occurrence network.
5. Keyword co-occurrence network.

#### V. CONCLUSION

In this paper, we conducted a brief survey of the literature on bibliometric analysis and visualization. We also analysed four websites that present COVID-19 bibliometric data. Additionally, we proposed a framework for visualizing bibliometric data associated with computer science research and COVID-19. The study paper's strength comes from the variety of bibliometric methodologies proposed and the systematic nature of its analysis. However, its primary shortcoming is the absence of technical specifics regarding the findings of the bibliometric analysis. In the future, we will conduct a bibliometric analysis utilising our proposed technique on VOSviewer. Additionally, we will validate our framework using Biblioshiny tool. We anticipate that our proposed method for visualizing bibliometric data will serve as a starting point for further development. It will make a substantial contribution to the exploration of bibliometric visualisation in any field, not limited to computer science.

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