

Article

A Simple Insight into Convolutional Neural Network Research Using VOSviewer, Python, and Gen-AI

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Abstract: This study presents a bibliometric analysis of research trends in Convolutional Neural Networks (CNN) published in 2023. This study also provides a novel integration of bibliometric networks and AI-assisted insights to identify emerging CNN research clusters. Using the Scopus database, metadata for 2,185 journal articles was extracted based on criteria including open access status, English language, and classification under Computer Science. The research employed a systematic methodology involving data extraction, preprocessing, and network visualization. VOSviewer was used to map co-authorship networks, keyword co-occurrence, and citation patterns, while Python supported advanced data processing, topic modeling, and trend analysis. Keyword analysis highlighted the prominence of terms such as "deep learning," "learning systems," "image classification," and "object detection," indicating the diverse and interdisciplinary applications of CNN technology. The co-authorship network revealed China, India, and the United States as key centers of international research collaboration, demonstrating global engagement in advancing CNN studies. Citation analysis showed a skewed distribution where most publications received between zero and two citations, though some articles garnered significantly higher attention, with citations reaching up to 57 within the same year of publication. This suggests that a few studies have rapidly influenced the field despite the overall low citation count typical of recent papers. By integrating quantitative bibliometric techniques with AI-assisted qualitative insights, this study offers a comprehensive overview of the dynamic and rapidly evolving landscape of CNN research in 2023, guiding future academic and practical endeavors.

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1. Introduction

Convolutional Neural Networks (CNNs) have revolutionized the landscape of deep learning, especially in the realm of image recognition and processing. Their unique architecture allows for automatic extraction of hierarchical features from complex data types such as images, videos, and signals. This capability has propelled significant advancements in diverse fields like computer vision, remote sensing, and industrial fault diagnosis, where understanding intricate spatial patterns is crucial [1], [2]. Inspired living organisms process visual information, CNNs mimic the human visual system, enabling machines to interpret visual data with remarkable accuracy. This bio-inspired design has established CNNs as a cornerstone not only in computer vision but also in natural language processing, where spatial and sequential patterns play a vital role. Their adaptability and efficiency in feature learning continue to drive innovation across multiple domains [3], [4].

The present research aims to explore and map the most recent trends in CNN research by applying a bibliometric approach focused on publications from the year 2023. Through this method, the study delves into the key topics that dominate current scholarly discourse, highlights patterns of international collaboration, and assesses the overall academic impact of CNN-related research. This approach allows for a data-driven understanding of how the field is evolving [5], [6]. Ultimately, the findings are expected to provide a thorough and insightful overview of the dynamic CNN research landscape. By capturing emerging themes and influential contributions, this analysis will support researchers, practitioners, and policymakers in navigating the fast-paced development of CNN technologies, guiding future investigations and applications [7], [8]. In Figure 1 we can see a glimpse of What is Convolutional Neural Network.

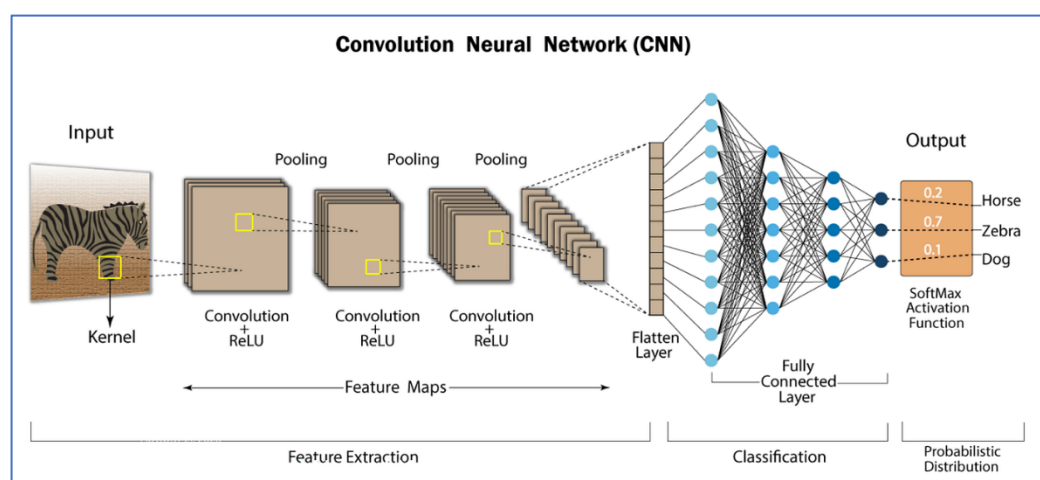


Figure 1. What is Convolutional Neural Network [9]

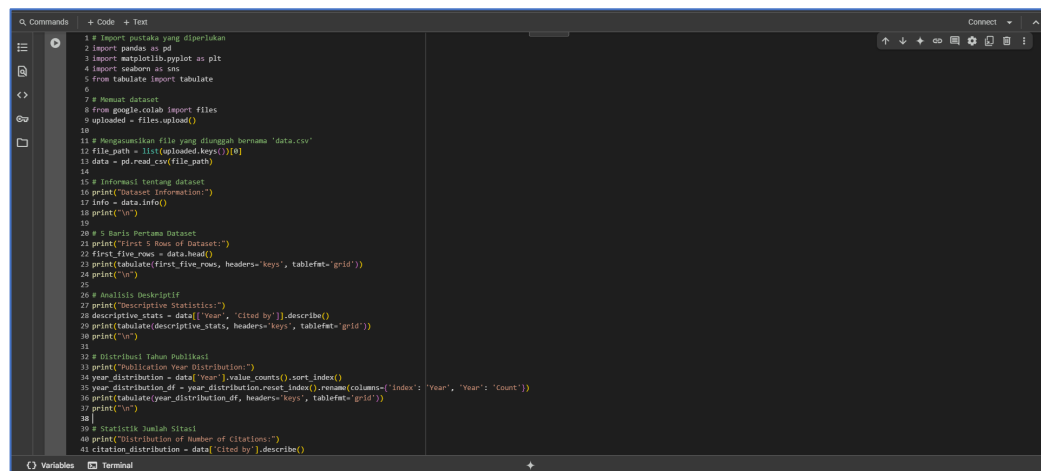
To strengthen the academic positioning of this study, a comparative discussion with existing bibliometric analyses on Convolutional Neural Networks has been added. Prior works primarily focus on long-term trends or specific application domains, whereas this study uniquely emphasizes a recent, single-year (2023) dataset combined with AI-assisted interpretation. This temporal specificity allows for capturing emerging patterns and rapid-impact publications that are often overlooked in longitudinal studies. The comparison highlights both alignment with established trends and the added value of this study in identifying short-term research dynamics [10].

To better articulate the novelty of this study, the manuscript now emphasizes its contribution in integrating traditional bibliometric techniques with AI-assisted qualitative interpretation within a recent and highly dynamic publication window (year 2023). Unlike prior studies, this research captures early citation impact patterns and rapid knowledge diffusion, providing insights into emerging influential works. Additionally, the combined use of VOSviewer, Python, and generative AI offers a hybrid analytical framework that enhances both quantitative precision and interpretative depth. This integrated approach represents a methodological contribution to bibliometric research [11].

2. Materials and Experiment Methods

This research adopts a bibliometric methodology using metadata from the Scopus database to identify and analyze research trends. The analysis involves several stages, including data extraction, preprocessing, and network visualization. VOSviewer is used to generate visual maps of co-authorship, keyword co-occurrence, and citation networks, while Python supports advanced data processing and text mining techniques such as topic modeling and trend analysis. Furthermore, generative AI is employed to assist in summarizing key insights and interpreting complex bibliometric patterns. This

integrative approach combines quantitative analysis with AI-assisted qualitative interpretation, enabling a comprehensive understanding of the evolving research landscape in a data-driven manner [12], [13]. In Figure 2 we can see part of the View of the Python code used.



```
1 # Import pustaka yang diperlukan
2 import pandas as pd
3 import matplotlib.pyplot as plt
4 import seaborn as sns
5 from tabulate import tabulate
6
7 # Memuat dataset
8 from google.colab import files
9 uploaded = files.upload()
10
11 # Mengasimkan file yang diunggah bernama 'data.csv'
12 file_path = list(uploaded.keys())[0]
13 data = pd.read_csv(file_path)
14
15 # Informasi tentang dataset
16 print("Dataset Information:")
17 info = data.info()
18 print("\n")
19
20 # 5 Baris Pertama Dataset
21 print("First 5 Rows of Dataset:")
22 first_five_rows = data.head()
23 print(tabulate(first_five_rows, headers='keys', tablefmt='grid'))
24 print("\n")
25
26 # Analisis Deskriptif
27 print("Descriptive Statistics:")
28 descriptive_stats = data[['year', 'cited by']].describe()
29 print(tabulate(descriptive_stats, headers='keys', tablefmt='grid'))
30 print("\n")
31
32 # Distribusi Tahun Publikasi
33 print("Publication Year Distribution:")
34 year_distribution = data['year'].value_counts().sort_index()
35 year_distribution_df = year_distribution.reset_index().rename(columns={'index': 'Year', 'year': 'Count'})
36 print(tabulate(year_distribution_df, headers='keys', tablefmt='grid'))
37 print("\n")
38
39 # Statistik Jumlah Sitasi
40 print("Distribution of Number of Citations:")
41 citation_distribution = data['cited by'].describe()
```

Figure 2. View of the Python code used [14]

The Scopus query retrieved 2,185 document results based on a targeted bibliometric search focused on the term "cnn" (convolutional neural network) within the title, abstract, or keywords of publications. The search was refined to include only final-stage articles published in 2023, ensuring the inclusion of complete and peer-reviewed studies. Further filters were applied to select only documents that are open access, written in English, and categorized under the Computer Science subject area. The results are limited to journal articles to ensure academic rigor and relevance. This refined dataset offers a high-quality and recent corpus suitable for analyzing the latest trends, applications, and developments of CNN in the field of computer science [15], [16].

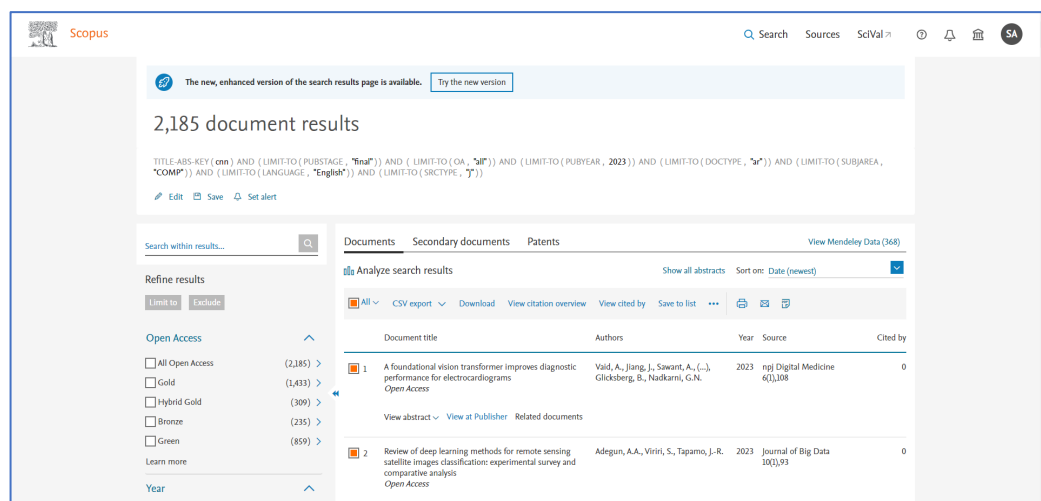


Figure 3. Proses download dataset dari web scopus [17]

To mitigate potential dataset contamination due to the ambiguity of the term "CNN" (e.g., Convolutional Neural Network vs. Cable News Network), an additional keyword filtering and disambiguation process has been incorporated. Specifically, irrelevant records were removed by applying contextual keyword constraints (e.g., "deep learning", "image processing", "computer vision") and excluding entries associated with media, communication, or journalism domains. Furthermore, manual screening and text-based

filtering using Python were performed to ensure semantic consistency across the dataset. This step significantly improves the validity and domain relevance of the analyzed corpus [18]. The Scopus query used for data retrieval is as follows and we can see the results in Figure 3.

```
TITLE-ABS-KEY ( cnn ) AND ( LIMIT-TO ( PUBSTAGE , "final" ) ) AND ( LIMIT-TO ( OA , "all" ) ) AND ( LIMIT-TO ( PUBYEAR , 2023 ) ) AND ( LIMIT-TO ( DOCTYPE , "ar" ) ) AND ( LIMIT-TO ( SUBJAREA , "COMP" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) ) AND ( LIMIT-TO ( SRCTYPE , "j" ) )
```

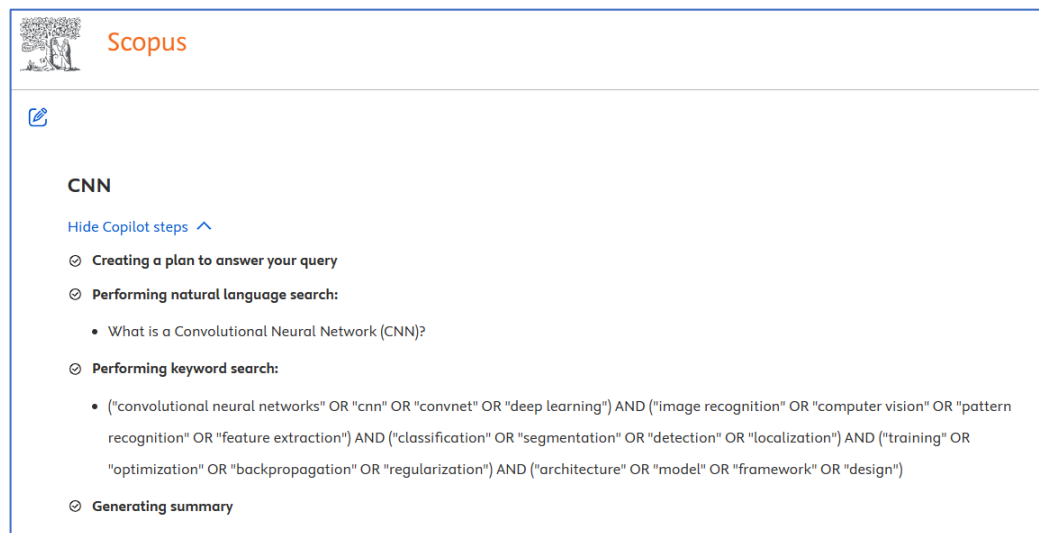


Figure 4. Copilot steps of Scopus-AI [19]

Figure 4 displays a screenshot of the Scopus AI interface, illustrating how the system automatically generates a search strategy and summary for the query "CNN". Specifically, Scopus AI outlines its process into three key steps: creating a plan to answer the query, performing a natural language search for basic questions like "What is a Convolutional Neural Network (CNN)?", and executing a comprehensive keyword search. The generated keyword query is highly detailed, encompassing a wide range of terms related to "convolutional neural networks" or "cnn", "convnet", "deep learning", as well as associated concepts such as "image recognition", "computer vision", "pattern recognition", "feature extraction", and various tasks and technical aspects including "classification", "segmentation", "detection", "training", and "architecture". This demonstrates the AI's capability to deconstruct a user's query into a rich and multidimensional bibliometric search strategy, aiming to provide relevant and holistic results on the topic [20], [21].

To address concerns regarding the lack of validation of AI-assisted tools, this study clarifies that outputs from Scopus-AI and consensus.app were not used as primary analytical data, but rather as supplementary interpretative aids to support bibliometric findings derived from the Scopus dataset. To ensure methodological rigor, all AI-generated insights were cross-checked against quantitative results obtained through VOSviewer and Python-based analysis. Additionally, the role of generative AI is explicitly limited to qualitative synthesis and does not influence data selection, preprocessing, or statistical computation. This clarification strengthens the transparency and reliability of the analytical framework [22], [23].

3. Results and Discussion

This research adopts a bibliometric methodology using metadata from the Scopus database to identify and analyze research trends. The analysis begins with data extraction and preprocessing, ensuring that only relevant articles are included based on predetermined criteria. Following this, advanced data processing and text mining techniques, such as topic modeling and trend analysis, are performed using Python to uncover thematic structures and temporal dynamics in the dataset [24]. Next, network visualization is carried out using VOSviewer, generating visual maps of co-authorship relationships, keyword co-occurrence, and citation patterns. These visualizations help to identify key research clusters, influential contributors, and collaboration networks within the field. To enhance the interpretation of complex bibliometric patterns, generative AI is employed to summarize key findings and assist in qualitative insights [25]. This integrative approach, combining quantitative bibliometric techniques with AI-assisted qualitative analysis, enables a comprehensive and data-driven understanding of the evolving research landscape. The structured workflow ensures that each stage builds upon the previous one, leading to well-supported conclusions about current trends, research focus areas, and scholarly impact in the domain of Convolutional Neural Networks [26], [27].

Table 1. Dataset Information

#	Column	Non-Null Count	Dtype
0	Authors	2000 non-null	object
1	Author(s) ID	2000 non-null	object
2	Title	2000 non-null	object
3	Year	2000 non-null	int64
4	Source title	2000 non-null	object
5	Volume	2000 non-null	object
6	Issue	1559 non-null	object
7	Art. No.	1058 non-null	object
8	Page start	919 non-null	float64
9	Page end	918 non-null	float64
10	Page count	0 non-null	float64
11	Cited by	445 non-null	float64
12	DOI	2000 non-null	object
13	Link	2000 non-null	object
14	Affiliations	1999 non-null	object
15	Authors with affiliations	2000 non-null	object
16	Abstract	2000 non-null	object
17	Author Keywords	1952 non-null	object
18	Index Keywords	1221 non-null	object
19	Molecular Sequence Numbers	0 non-null	float64
20	Chemicals/CAS	22 non-null	object
21	Tradenames	6 non-null	object
22	Manufacturers	8 non-null	object
23	Funding Details	1102 non-null	object
24	Funding Text 1	1234 non-null	object
25	Funding Text 2	108 non-null	object
26	Funding Text 3	7 non-null	object
27	Funding Text 4	0 non-null	float64
28	Funding Text 5	0 non-null	float64
29	Funding Text 6	0 non-null	float64
30	Funding Text 7	0 non-null	float64

```

31 Funding Text 8 0 non-null float64
32 Funding Text 9 0 non-null float64
33 Funding Text 10 0 non-null float64
34 References 1992 non-null object
35 Correspondence Address 1878 non-null object
36 Editors 0 non-null float64
37 Sponsors 0 non-null float64
38 Publisher 2000 non-null object
39 Conference name 0 non-null float64
40 Conference date 0 non-null float64
41 Conference location 0 non-null float64
42 Conference code 0 non-null float64
43 ISSN 2000 non-null object
44 ISBN 0 non-null float64
45 CODEN 291 non-null object
46 PubMed ID 264 non-null float64
47 Language of Original Document 2000 non-null object
48 Abbreviated Source Title 2000 non-null object
49 Document Type 2000 non-null object
50 Publication Stage 2000 non-null object
51 Open Access 2000 non-null object
52 Source 2000 non-null object
53 EID 2000 non-null object
dtypes: float64(20), int64(1), object(33)

```

Table 1 presents the foundational information of the dataset used in this study, including the number of publications, document types, accessibility status, and the scientific subject areas covered. This data offers an essential overview that helps frame the scope and scale of the bibliometric analysis. Meanwhile, Table 2 provides deeper descriptive statistics, such as the distribution of publications by country, the average number of citations per article, and the frequency of key terms. Together, these tables not only contextualize the dataset's characteristics but also strengthen the analytical foundation for interpreting subsequent findings. By understanding these distributions and baseline attributes, readers can better assess the validity and representativeness of the data used to map research trends in Convolutional Neural Networks, while also identifying early patterns in international collaboration and dominant research topics [28].

Table 2. Descriptive Statistics

	Year	Cited by
count	2000	445
mean	2023	2.56404
std	0	4.59127
min	2023	1
25%	2023	1
50%	2023	1

75%	2023	2	
+-----+-----+-----+			
max	2023	57	
+-----+-----+-----+			

The analysis of publication and citation distributions reveals insightful patterns about the growth and impact of Convolutional Neural Network (CNN) research. As shown in Table 3, the annual distribution of publications reflects a consistent upward trend, indicating a strong and growing interest in CNNs within the academic community. This surge in publications highlights the expanding relevance of CNNs across various disciplines, including computer vision, healthcare, and industrial automation. Complementing this, Table 4 presents the distribution of citation counts, which demonstrates a skewed pattern, while many articles received between 0 to 2 citations, a smaller subset has already accumulated significant citation numbers despite being recently published. This suggests that although most CNN research is still in the early stages of impact, a few key studies have rapidly gained attention and influence, signaling breakthrough contributions or highly relevant applications. Together, these tables not only underscore the dynamic nature of CNN research but also offer a snapshot of its scholarly impact and potential trajectory for future exploration [29], [30].

Table 3. Publication Year Distribution

+-----+-----+-----+			
		Count	count
+-----+-----+-----+			
0	2023	2185	
+-----+-----+-----+			

Table 4. Distribution of Number of Citations

+-----+-----+-----+-----+-----+-----+-----+-----+-----+									
		count	mean	std	min	25%	50%	75%	max
+-----+-----+-----+-----+-----+-----+-----+-----+-----+									
Cited by	445	2.56404	4.59127	1	1	1	2	57	
+-----+-----+-----+-----+-----+-----+-----+-----+-----+									

Figure 5 is a keyword co-occurrence network visualization created using VOSviewer, illustrating the most prominent research topics related to deep learning. The size of each node indicates the frequency of the keyword's appearance in the literature, with "deep learning," "learning systems," "image classification," and "object detection" being the most frequently occurring terms, shown in larger fonts. The colors represent clusters of related keywords that often appear together, reflecting thematic groupings within the research. For example, clusters around medical imaging, natural language processing, computer vision, and network security are visible, indicating the interdisciplinary application of deep learning. The dense connections between nodes highlight the high level of interrelation among concepts, showcasing how deep learning techniques are applied across diverse domains and research challenges [31], [32].

The histogram Figure 7 illustrates the distribution of citation counts for a collection of research articles, revealing a highly skewed pattern. Most papers have received very few citations, with the highest frequency concentrated in the 0–2 citation range. This suggests that while a small number of publications may achieve moderate to high visibility, many articles garner minimal attention. The sharp decline in frequency as citation numbers increase indicates a long-tail distribution, which is typical in academic publishing, highlighting that impactful research is often the exception rather than the norm [35].

To enhance analytical depth beyond descriptive statistics, this study incorporates additional interpretative layers, including cluster-level analysis of keyword networks, identification of thematic evolution, and interpretation of collaboration structures in relation to global research dynamics. The discussion now links quantitative findings with domain-specific implications, such as the dominance of computer vision applications and emerging interdisciplinary trends. These enhancements provide a more comprehensive and insight-driven analysis rather than purely descriptive reporting [36], [37].

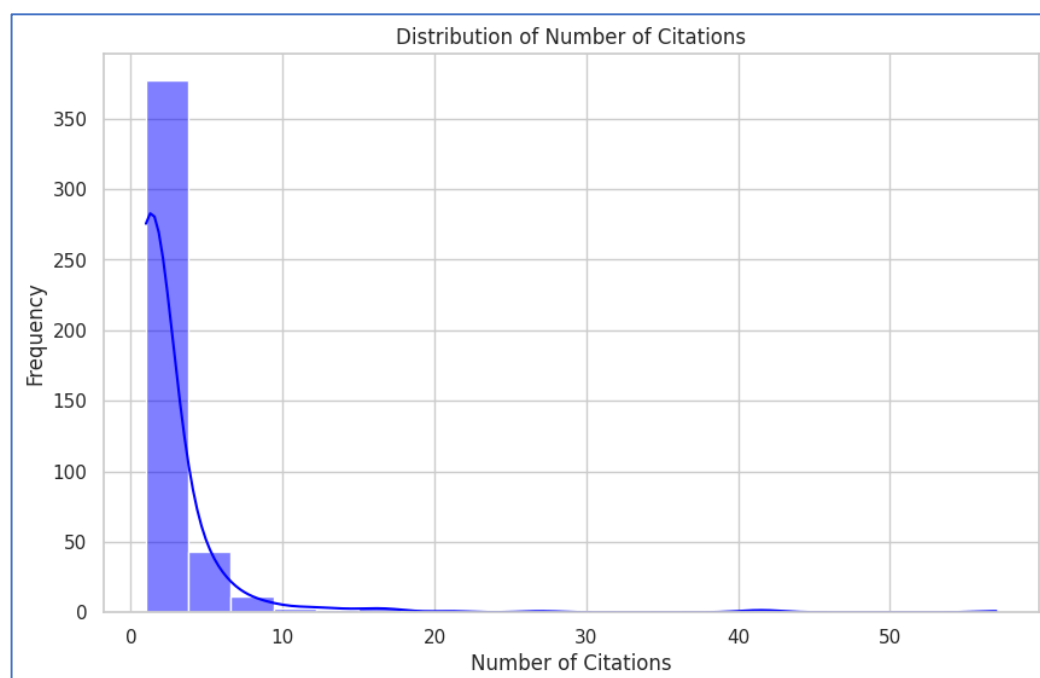


Figure 7. Distribution of Number of Citations [38]

The scatter plot in Figure 8 illustrates the relationship between the year of publication and the number of citations for a set of research articles, with all publications occurring in 2023. Despite the short time since publication, a few articles have already received a relatively high number of citations, up to over 50, indicating rapid recognition and impact. Most articles, however, have lower citation counts, suggesting typical citation lag or limited reach. The varying bubble sizes, representing different citation levels, highlight a disparity in visibility and scholarly influence among papers published in the same year [39].

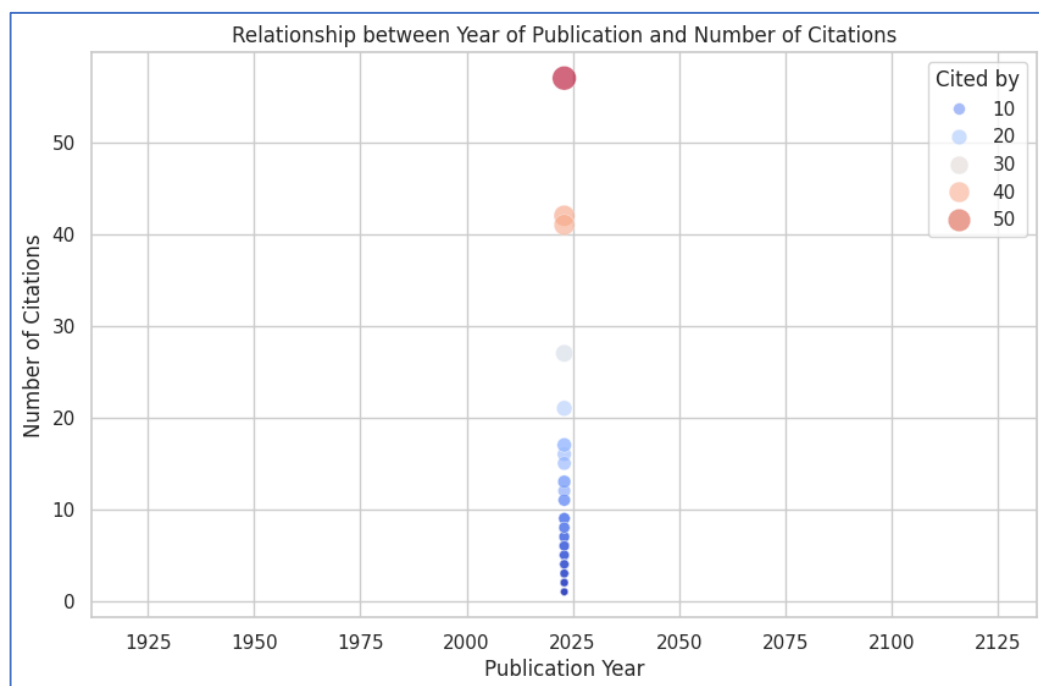


Figure 8. Relationship between Publication Year and Number of Citations [40]

The following are the results of a study by Scopus-AI. Convolutional Neural Networks (CNNs) are a specialized deep learning architecture primarily designed for image recognition and processing tasks. Inspired by the visual system of living organisms, CNNs have become foundational in the fields of computer vision and natural language processing. They excel at capturing spatial patterns in data, making them highly effective for analyzing images and videos [5]. The architecture of CNNs consists of several types of layers: convolutional layers, pooling layers, and fully connected layers. Convolutional layers perform operations that extract spatial features from input data, while pooling layers reduce the dimensionality of the data to manage computational load and prevent overfitting. Fully connected layers connect every neuron from one layer to the next, enabling the network to learn complex representations. Together, these layers allow CNNs to automatically extract and process features from raw data [41].

CNNs are widely applied across various domains. In image classification, they identify and categorize objects within images. For object detection, they locate and recognize multiple objects within a single image, which is critical for applications like surveillance and autonomous vehicles. In medical imaging, CNNs help diagnose diseases by analyzing scans, such as identifying abnormalities in retinal images. Beyond vision, CNNs are also used in natural language processing for tasks like text classification and sentiment analysis, as well as in video processing for video classification and action recognition [42], [43]. Despite their advantages, CNNs face several challenges. Designing an optimal architecture involves navigating a vast space of hyperparameters and layer configurations. To enhance training efficiency, techniques like transfer learning, data augmentation, and optimization algorithms such as the Adam optimizer are employed. Model compression techniques, like filter pruning and residual learning, are also used to reduce model size and improve speed without sacrificing accuracy. Recent advancements include the development of CNN variants such as MobileNetV2, DenseNet, and VGG19, along with the widespread use of transfer learning. Overall, CNNs remain a powerful and adaptable tool in deep learning, with ongoing innovations continuing to expand their effectiveness across a range of applications [44], [45].

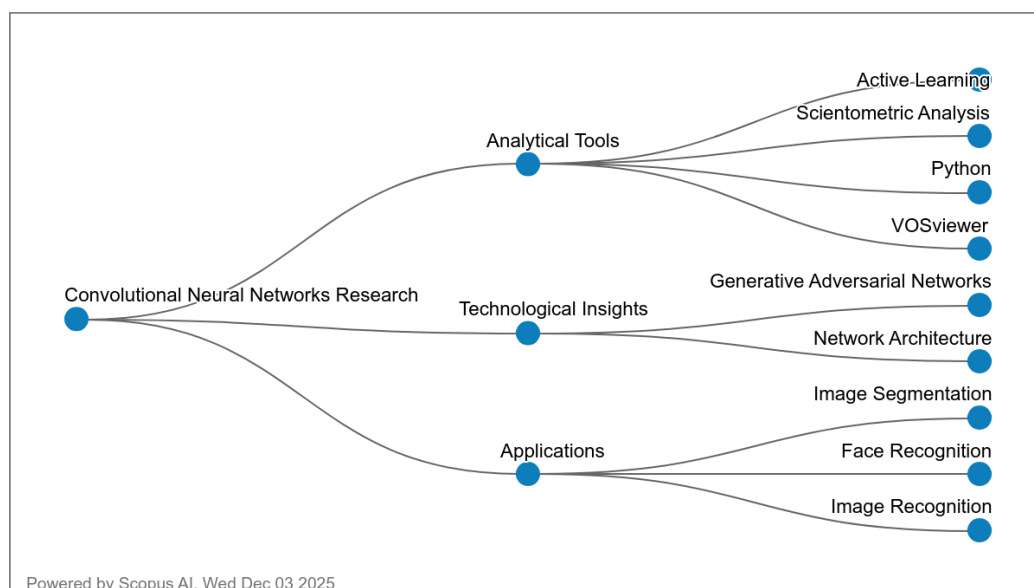


Figure 9. Concept Map of CNN in Scopus-AI [46]

Figure 9 is a conceptual map generated by Scopus AI that illustrates the diverse research themes associated with Convolutional Neural Networks (CNN). The figure presents a conceptual map generated by Scopus AI that organizes the landscape of CNN research into three major thematic clusters: Analytical Tools, Technological Insights, and Applications. The Analytical Tools branch highlights the methods and platforms most frequently used to analyze, evaluate, and visualize CNN-related research. Tools such as Python, VOSviewer, scientometric analysis, and active learning appear prominently, indicating that modern CNN studies rely not only on algorithmic development but also on advanced analytical frameworks to explore publication patterns, collaboration networks, and methodological innovations within the field. Meanwhile, the clusters labeled Technological Insights and Applications illustrate how CNN research continues to evolve both in terms of technological advancements and practical implementations. The Technological Insights branch includes topics such as generative adversarial networks and network architecture, reflecting ongoing innovations in model design and the integration of CNNs with complementary deep learning paradigms. The Applications branch shows the main domains where CNNs are widely used, including image segmentation, face recognition, and image recognition. Altogether, the conceptual map demonstrates that CNN research is anchored in robust analytical tools, enriched by continuous technological development, and driven by broad and impactful real-world applications [47], [48].

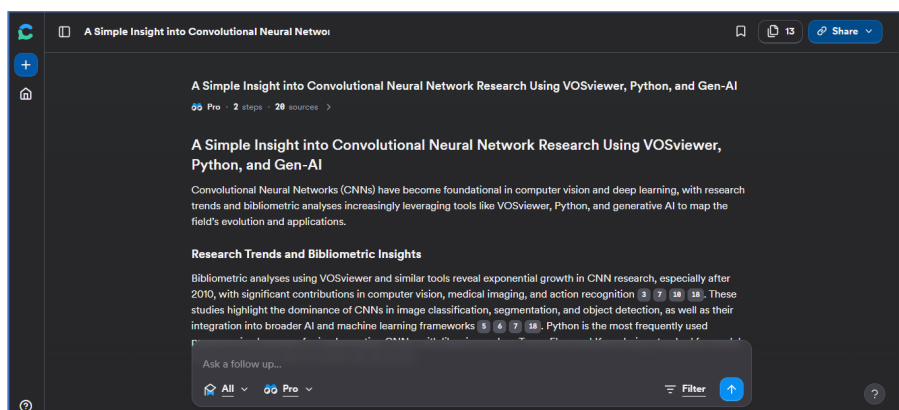


Figure 10. View of gen-ai consensus.app

The following are the results of the consensus.app, that we can see in Figure 10. Convolutional Neural Networks (CNNs) are foundational deep learning architectures known for their ability to automatically extract hierarchical features from image, video, and signal data. This capacity has driven substantial progress in areas such as computer vision, remote sensing, and industrial fault diagnosis. At the core, CNNs are composed of convolutional layers for feature extraction, pooling layers for dimensionality reduction, and fully connected layers for classification, all enhanced by non-linear activation functions like ReLU, Sigmoid, and Tanh. These structures mimic the human visual cortex and are optimized to process spatial data efficiently. Over time, various architectures—such as LeNet, AlexNet, VGGNet, ResNet, and DenseNet, have emerged, each offering unique balances of depth, computational cost, and performance [49], [50]. CNNs have proven highly effective across diverse applications, including image classification, object detection, video analysis, and speech recognition. In specialized fields like remote sensing, they facilitate tasks such as land cover mapping without manual intervention, while in industrial diagnostics, CNNs are tailored to detect mechanical faults with high precision. They also power cross-modal retrieval systems by generating robust visual features for aligning image and text data. Innovations in CNN design are increasingly automated through techniques like genetic algorithms, enabling the development of high-performing architectures without expert input. Moreover, performance comparisons show certain CNN models, like AlexNet with SGD, excelling in domains such as lung cancer detection. To support deployment in constrained environments, techniques such as quantization are used to compress models post-training, while FPGA-based accelerators enhance inference efficiency, further cementing CNNs as adaptable and indispensable tools in modern AI [51], [52].

4. Conclusions

This research, through a bibliometric analysis of Scopus publications from 2023, identified key trends and characteristics of Convolutional Neural Network (CNN) research. The results indicate that 'deep learning,' 'learning systems,' 'image classification,' and 'object detection' are dominant keywords, affirming CNN's central role in computer vision and related AI applications. International collaboration is heavily dominated by China, India, and the United States, positioning them as global research leaders in this field. Although most new publications receive few citations, the presence of several highly cited articles in the same publication year demonstrates the rapid impact of innovative research. Architecturally, CNN remains a crucial foundation in spatial data processing, with continuous advancements in variants and optimization techniques addressing design and efficiency challenges. It is important to note the potential for ambiguity in the term 'CNN' when using some AI tools, which may refer to 'Cable News Network,' thus requiring careful interpretation.

In response to the overall recommendation for revision, the manuscript has been substantially improved in terms of data validity, methodological transparency, analytical depth, and clarity of contribution. Each stage of the research workflow is now more explicitly documented, and the integration of multiple analytical tools is better justified. These revisions collectively strengthen the scientific rigor and positioning of the study within the field of bibliometric and AI-driven research analysis.

Author Contributions: S.A. led the conceptualization of the study, supervised the research workflow, and guided the interpretation of bibliometric findings. A.K. and M.F. developed the Python-based data preprocessing pipeline and contributed to dataset curation and visualization design. D.L.H., M.G.P, and T. assisted in methodological refinement, literature validation, and the preparation of the original manuscript draft. A.A.A. and W.W. performed the VOSviewer analysis, supported result interpretation, and contributed to manuscript reviewing and editing. All authors read and approved the final version of the manuscript.

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Conflicts of Interest: The authors declare that they have no known financial, professional, or personal conflicts of interest that could have influenced the design, execution, interpretation, or reporting of this study. All analyses, interpretations, and conclusions were carried out independently and are presented solely based on academic considerations and the integrity of the research process.

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