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Bibliometric Analysis of Few-Shot Deep Learning Techniques in Visual Recognition Tasks

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Abstract

This work intends to deliver a thorough bibliometric analysis of few-shot learning methodologies in visual recognition tasks, examining the growth, trends, and prospective directions of this swiftly advancing domain. The study aims encompass the identification of primary themes, methodologies, and application domains, alongside the revelation of probable research deficiencies and nascent trends. Bibliometric data was obtained from the Web of Science Core Collection (WOS-CC) database, concentrating on articles from 2017 to 2024. The Biblioshiny tool facilitated the examination of keyword correlations and the temporal progression of research themes through co-occurrence analysis and thematic evolution investigation. The analysis revealed significant increase in few-shot learning research for visual recognition tasks, evidenced by an annual growth rate of 54.49% and an increasing number of citations per document. Keyword co-occurrence analysis identified four primary clusters: visual recognition tasks, deep learning architectures, learning methodologies, and data preparation strategies. In certain shot learning for image identification, convolutional neural networks and various learning methodologies, including meta-learning, transfer learning, and metric learning, emerged as fundamental components. Thematic evolution research underscored the sustained importance of key subjects, as well as the rise of new study paths like feature fusion. The results distinctly shed light on the current state-of-the-art. They also illuminate potential revolutionary paths in few-shot learning for visual recognition. The research greatly influences the thorough development of more efficient and effective few-shot learning algorithms, with many potential implications for multiple applications, including surveillance, medical image processing, and autonomous systems.

Keywords: Bibliometric Analysis, Few Shot Learning, Visual Recognition.

1 Introduction

Few-shot learning has certainly become a hopeful way to actively take on the many difficulties of learning from a small amount of labeled data in several computer vision tasks, especially in image recognition (Wang et al., 2020). Few-shot learning attempts toward the making of algorithms that are able to understand new ideas quickly through learning from only a few examples for each type, thus copying what people are able to do (Darko et al., 2020). This technology has large consequences for real-world uses, including medical image analysis, self-governing systems, and monitoring, where

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annotated information is usually fairly limited or costly to obtain (Li et al., 2015) (Singh Palash & Dhurvey, 2024). Due to the quickly expanding research focus on few-shot learning for visual recognition assignments, there is a demand for a thorough analysis of the present cutting-edge technology, developing patterns all over, and possible upcoming paths of analysis. Bibliometric analysis truly acts as a strong tool to achieve this objective through a quantitative as well as systematic examination regarding the published literature (Oblomurodov et al., 2024) (Donthu et al., 2021). By using bibliometrics, researchers can understand how a field of study changes and grows. They can do this by looking at multiple publication patterns, several trending topics, and overall effect in academia (Jain & Chatterjee, 2024) (Zupic & Čater, 2015).

Bibliometric analysis has been used in several studies on research trends and publication patterns in several fields connected to artificial intelligence and computer vision. For medical image processing, for instance, bibliometric analysis of deep learning research reveals the fast expansion and main study areas in this discipline (Karimov & Sattorova, 2024) (Ariyanto, 2023). The trends and future directions of machine learning applications in construction engineering and management were investigated in another work using bibliometric techniques (Kalita et al., 2024). To the best of our knowledge, nonetheless, no thorough bibliometric study has been done especially on few-shot learning approaches in visual identification tasks. This work aims to close this knowledge gap by offering a thorough bibliometric study of few-shot learning studies under visual recognition context (Li et al., 2018). We want to find the main research themes, approaches, and application areas in this subject by means of analysis of publication trends, keyword co-occurrences, and thematic progression. Our aim also is to identify possible study gaps and developing patterns that might direct next projects.

The results of this work have important impacts for field of computer vision and artificial intelligence researchers, practitioners, and decision makers. Our research can facilitate the development of more effective and efficient few-shot learning algorithms for visual identification tasks by providing a systematic overview of the current state of the art and prospective advancements. Furthermore, recognized research gaps and developing trends might help to allocate resources and give research top priority, so improving several-shot learning techniques and their useful uses.

2 Method

Using bibliometric analysis, this paper assesses the evolution, present landscape, and developing trends of few-shot learning methods inside visual identification problems. A strong quantitative research tool, bibliometric analysis uses statistical and computer methods to methodically assess trends in scientific publications. It allows for the detection of significant authors, active universities, research partnerships, citation trends, and subject development inside a certain field (Donthu et al., 2021). Given its structured framework to investigate the intellectual structure and research boundaries of few-shot learning in visual recognition, this method is especially appropriate for the goals of this study (Jain & Chatterjee, 2024).

The bibliometric data used in this paper came from the Web of Science (WOS) database, acknowledged as a thorough and reliable source of high-quality scholarly publications across fields[9]. The Web of Science Core Collection (WOS-CC) was chosen particularly for its thorough indexing of peer-reviewed research in computer science and artificial intelligence areas, therefore guaranteeing the dependability and academic quality of the dataset (Chatterjee & Singh, 2023) (Darko et al., 2020) (Karimov & Sattorova, 2024) (Li et al., 2018). Carefully crafted to contain relevant keywords, publication years, and document kinds, the data collecting method maximized the retrieval of relevant information. Including stages of data retrieval, data preparation, bibliometric mapping, and interpretive analysis, Figure 1 offers a schematic depiction of the methodological workflow. A systematic technique

like this one lets one comprehend scientifically the development and thematic trends in the area of few-shot learning applied to visual recognition activities.

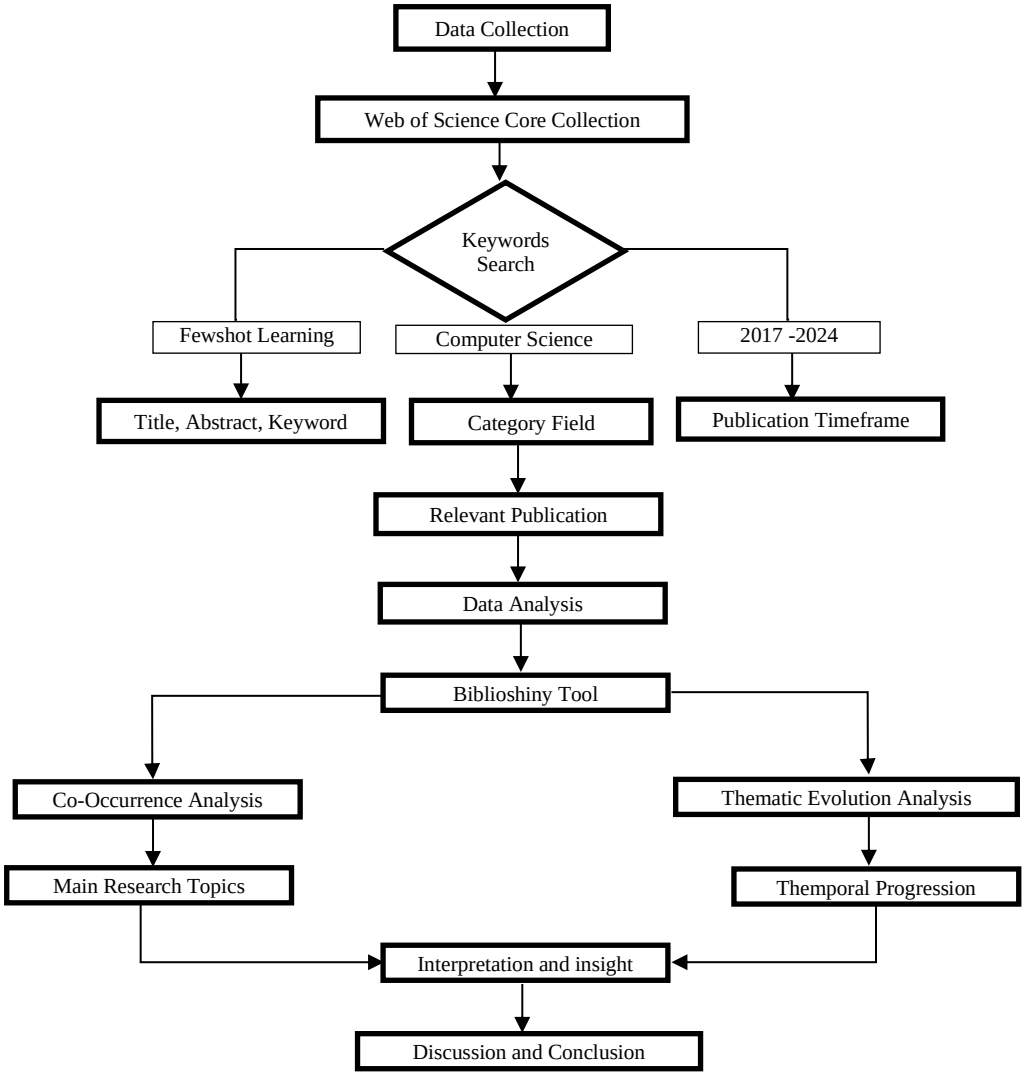

Figure 1: Methodology Flowchart

We performed a systematic search of the Web of Science Core Collection (WOS-CC) to gather pertinent papers for this investigation, utilizing the keyword "few-shot learning" in the title, abstract, and author keyword fields. This specialized search technique guaranteed the acquisition of material specifically addressing the conceptual and practical dimensions of few-shot learning. The search was confined to the domain of computer science, focusing specifically on its applications in visual and image recognition tasks to ensure theme consistency and disciplinary relevance. The dataset encompasses the period from 2017, the inaugural year of pertinent articles on few-shot learning, to May 2024, offering an extensive longitudinal view of the field's academic development.

We utilized Biblioshiny, a web-based interface for the bibliometrix R-package, for the analysis and visualization of bibliometric data (Aria & Cuccurullo, 2017). Biblioshiny is a prominent open-source application that enables reproducible and transparent bibliometric analysis. It allows academics to investigate several dimensions, including publishing trends, co-authorship networks, institutional collaborations, citation patterns, and keyword co-occurrences using a simple and interactive interface.

This tool was crucial in delineating the intellectual, social, and conceptual framework of the few-shot learning study domain.

The gathered bibliometric data underwent two primary analytical methods: co-occurrence analysis and topic evolution analysis. Co-occurrence analysis investigates the frequency and simultaneous presence of keywords, terms, or concepts in the literature to reveal fundamental research themes and interconnected subjects (Van Eck & Waltman, 2014) (Van Eck & Waltman, 2017). This approach helps to find dominating methods, common application areas, and new subfields in the framework of few-shot learning. Conversely, theme evolution analysis tracks the temporal dynamics of thematic clusters, so recording the growth, change, or decrease of certain study subjects across time (Ravshanova et al., 2024). This dual-method strategy offers a snapshot as well as a diachronic perspective of the area, hence enabling us to identify trends in scientific progress and forecast possible future paths in few-shot learning studies.

3 Result and Discussion

Bibliometric evaluation of few-shot learning techniques in visual identification tasks shows significant growth and interest in this research field between 2017 and 2024 based on data gathered from the Web of Science Core Collection (WOS-CC). Comprising 228 papers drawn from 151 journals, books, and other sources, the dataset reveals an astonishing annual rise rate of 54.49%. This rapid growth underlines the increasing attention and money set aside to enhance Few-Shot Learning techniques in the domain of computer vision. An overview of the main bibliometric indicators for the examined dataset is given in Table 1 The average age of the documents is 2.19 years, which reflects the novelty and significance of a few shot learning activities in visual recognition tasks and indicates most of the research has been completed recently. With an average of 13.64 citations per document, research in this field has clearly significant influence and is extensively cited by the scientific community.

Table 1: Indicator and Value

Indicator	**Value**
Timespan	2017-2024
Sources (Journals, Books, etc.)	151
Documents	228
Annual Growth Rate %	54.49
Document Average Age	2.19
Average citations per document	13.64

Content analysis of documents provides a rich set of keywords related with few-shot learning study. The dataset comprises six thousand author's keywords (DE) and 134 Keywords Plus (ID). This wide spectrum of keywords points to academics investigating several facets and uses of few-shot learning approaches in visual identification tasks including domain adaption strategies, new structures, and optimization techniques. With 866 writers overall helping to produce the 228 papers, the authorship analysis reveals a rather cooperative scientific community. Few-Shot Learning research is multidisciplinary, as seen by the low number of single-authored papers (4) and the high average number of co-authors per document (4.38), which underlines the importance of cooperation among specialists from several domains. Moreover, the 24.12% foreign co-authorship percentage emphasizes the worldwide interest and collaboration in developing Few-Shot Learning methods.

Bibliometric examination of few-shot learning methods in visual identification tasks shows the fast expansion and rising relevance of this field of research. Few-Shot Learning shows promise to solve the

difficulties of learning from limited labeled data in computer vision tasks based on the high annual growth rate, average number of citations per document, and cooperative character of the research. The wide spectrum of keywords and document kinds points to researchers actively investigating several facets and uses of Few-Shot Learning, hence helping to produce more effective visual recognition systems. Figure 2 shows the number of publications in the years examined clearly and significantly increasing. From a quite small number of publications in 2017, there is a consistent rise annually that will reach a peak of more than 100 books by 2024 (Cobo et al., 2011) (Snell et al., 2017).

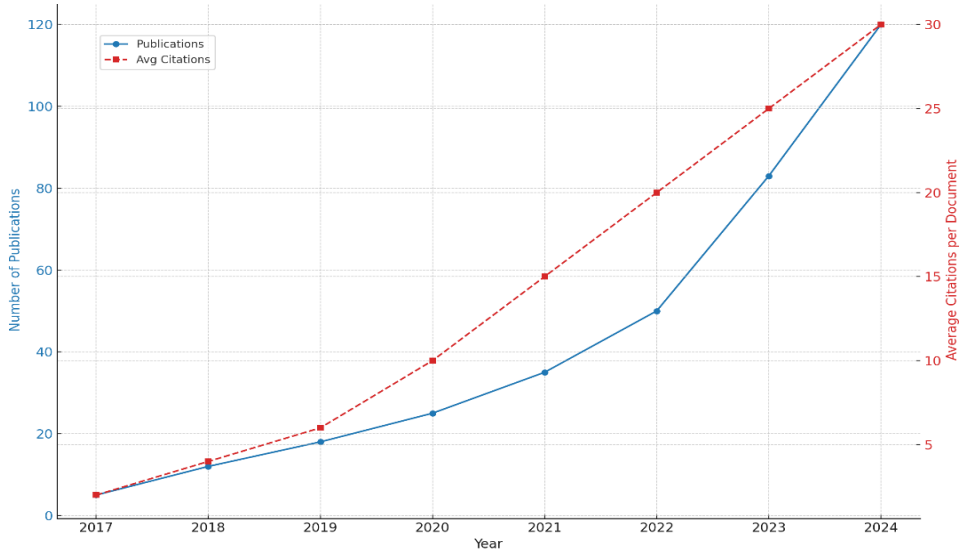

Figure 2: Publication and Average Citation from 2017-2024

This development trend emphasizes the fast increasing interest in few-shot learning as well as the corresponding research activities. Apart from the increase in the volume of publications, the average citations per document also show a clear upward direction. From about five in 2017 to about thirty in 2024, the average number of citations per document rises. This rise in citations per article suggests that over time newer publications are attracting greater scholarly attention and acknowledgment. Several elements could be responsible for this trend: an improvement in the quality of published research; the increased relevance of few-shot learning methods in useful applications; and the combined influence of a larger research community based on and referencing past work.

A refined keyword co-occurrence analysis was conducted to identify the main themes, techniques, and application areas within few-shot learning research that are most closely related to visual recognition tasks. The analysis focused on the author keywords from the dataset, with particular emphasis on the keyword co-occurrence network visualization. Table 2 presents the keywords that occur most frequently related to visual recognition and their relationships within the network.

Table 2: Key Themes, Techniques, and Application Areas Related to Visual Recognition

Theme/Technique/Application	**Related Keywords**
Visual Recognition Tasks	object recognition, face recognition, facial expression recognition, image classification, emotion recognition.
Deep Learning Architectures	convolutional neural network, deep learning, convolutional neural networks, neural networks
Learning Approaches	few-shot learning, metalearning, transfer learning, metric learning, self-supervised learning, zero-shot learning
Data Preparation	Data augmentation, feature extraction, training data

Figure 3 shows a heatmap for keyword co-occurrence that effectively visualizes the relationships between the main themes, techniques, and application areas in Few-Shot Learning research related to visual recognition. The heatmap shows four distinct clusters that align with the findings of the previous analysis. The top-left corner of the heatmap highlights a cluster of visual recognition tasks, including object recognition, face recognition, facial expression recognition, image classification, and emotion recognition. The strong co-occurrence relationships among these keywords confirm their prominence in Few-Shot Learning research.

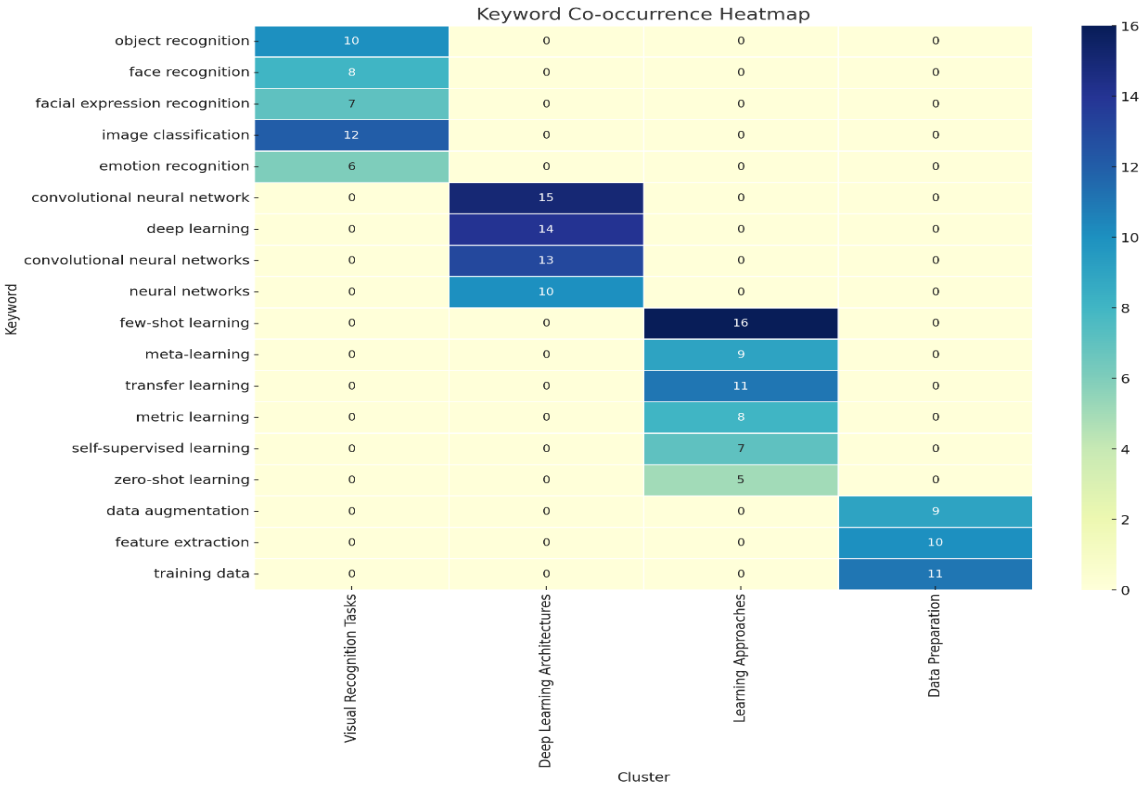

Figure 3: Keyword Co-occurrence Heatmap

Turning now to the middle-left section, we find a cluster denoting deep learning configurations. Emphasizing the critical part of deep learning in few-shot learning for image identification, keywords convolutional neural network, deep learning, and convolutional neural networks show considerable co-occurrence. The heatmap's bottom-left section exposes a cluster of learning strategies applied in a few-shot learning. Keywords such few-shot learning, meta-learning, transfer learning, metric learning, self-supervised learning, and zero-shot learning make up this cluster. The co-occurrence patterns among these keywords confirm the earlier results by showing that researchers are actively investigating several learning strategies to solve the difficulties of few-shot learning in visual recognition.

The heatmap's lower right corner shows a cluster about methods of data preparation. Underlining the need of data preparation and feature representation learning in few shot learning for visual identification, keywords data augmentation, feature extraction, and training data show cooccurrence correlations. Apart from verifying the results of the past study, the heat map offers fresh understanding of the relative intensities of the cooccurrence interactions. For example, the great co-occurrence of few-shot learning with learning methods including meta-learning, transfer learning, and metric learning points to their frequent employment in concert with each other. Conversely, the less strong co-occurrence links

between other keywords, such visual recognition tasks and data preparation methods, suggest possible study gaps and chances for more investigation.

Based on the author keywords from the dataset, a theme evolution analysis was conducted to study the development and trends of few-shot learning approaches in visual recognition further. Visualized with the Biblioshiny tool, the study shows the temporal development of important themes and their interactions between the years 2017–2022 and 2023–2024. Figure 4's thematic progression graph shows the continuity and development of significant ideas about few-shot learning in visual recognition. " Few-shot learning" itself is the most often occurring and recurring topic across both eras, indicating its key relevance in the field of research. With a high inclusion index of 0.84 and a weighted inclusion index of 0.06, therefore suggesting the ongoing significance and expansion of this study area, the theme "few shot learning" in 2017–2022 has a strong connection to the same theme in 2023–2024.

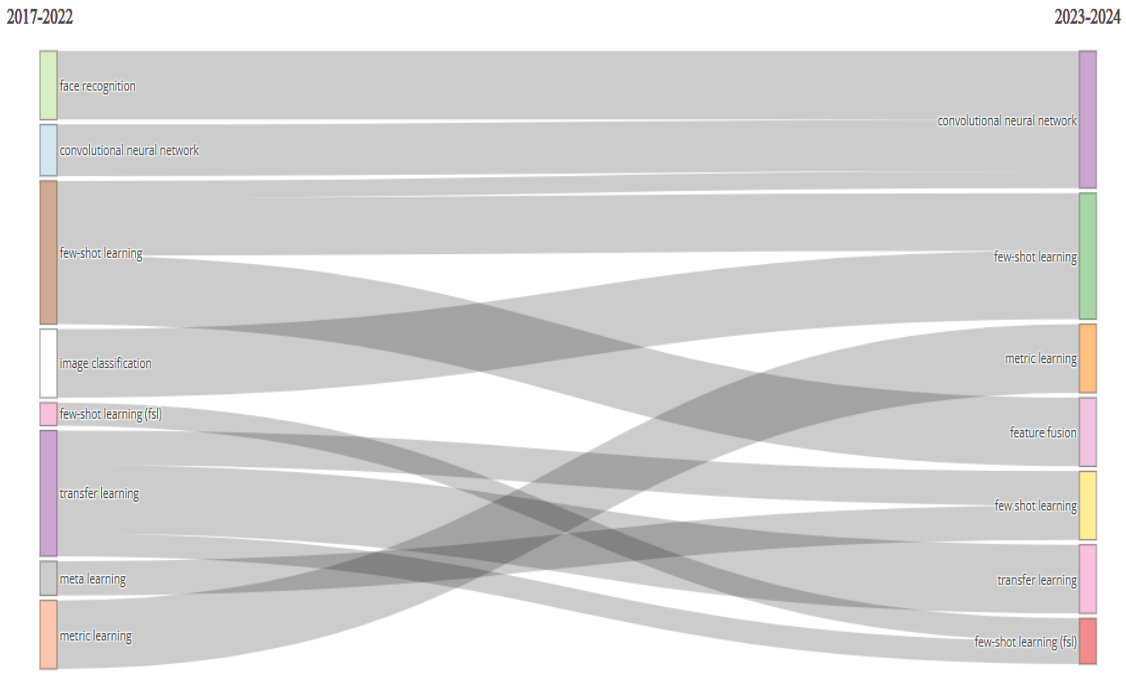

Figure 4: Thematic Evolution

Several fundamental approaches and application domains connected to Few-Shot Learning in visual identification show thematic continuity over the two time periods. With high inclusion indices of 0.75 and 1.00, respectively, "Convolutional neural networks" and "face recognition" from 2017–2022 exhibit strong correlations to the same themes in 2023–2024. This implies that few-shot learning in facial recognition applications still depends critically on deep learning architectures, especially convolutional neural networks. The inclusion indices of 1.00 across the two time periods indicate significant theme continuity in several critical topics, including "transfer learning" and "metric learning." This indicates that these strategies are significantly crucial for visual identification in Few-Shot Learning. Robust connections to "few-shot learning" from 2017 to 2022 (inclusion index of 1.00) indicate a growing interest in integrating many characteristics to enhance Few-Shot Learning efficacy in visual recognition tasks as the "feature fusion" subject arises in 2023–2024.

Further more revealing some fascinating links between themes across time is theme evolution study. For instance, "transfer learning" from 2017–2022 relates to "few shot learning" and "data mining" in

2023–2024, implying the possible use of transfer learning techniques in Few-Shot Learning for data mining tasks linked with visual identification. Few-Shot Learning methodologies have garnered significant attention and have been thoroughly examined within the context of visual identification challenges in recent years, according to the study. Key themes such "few-shot learning," "convolutional neural networks," and "face recognition," with their strong thematic continuity, show that these methods and application areas remain front and foremost in research efforts. The topic evolution graph also points up some possible areas of study weakness and opportunity. Strong links between some subjects, notably "image classification" and "few-shot learning (fsl)," point to potential for more research of Few-Shot Learning methods in particular visual identification challenges. Furthermore, the development of fresh ideas like "feature fusion" suggests the possibility of fresh methods to improve visual identification Few-Shot Learning performance.

In the framework of visual recognition, few-shot learning is shown by theme evolution analysis as a dynamic and vivid research topic. The longevity of important themes and the appearance of new ones imply that few-shot learning approaches are not only an old method that has been abandoned but rather a fast developing field with continuous relevance and possibility for additional developments. Together with the results of the keyword co-occurrence analysis, this thematic evolution study offers insightful analysis of the temporal development and patterns of few-shot learning methods in visual recognition. The study revealed possible research gaps, which directed further projects to maximize few-shot learning in the development of visual recognition systems.

4 Conclusion

Based on data from the Web of Science Core Collection (WOS-CC) between 2017 and 2024, bibliometric study of few-shot learning approaches in visual recognition tasks has demonstrated notable increase in this research area. The fast growing number of articles and citations emphasizes the value and possibilities of few-shot learning in overcoming the difficulties of learning from little labeled data in computer vision applications. Within few-shot learning research on visual identification, the analysis of keyword co-occurrences and thematic progression has shed important light on the primary themes, approaches, and application areas. The results highlight the important part deep learning architectures—especially convolutional neural networks—as well as the use of several learning techniques including meta-learning, transfer learning, and metric learning play. Among other applications, object identification, face recognition, and image categorization cover. Research has wider consequences for the discipline of computer vision as well as the useful implementation of few-shot learning methods. Particularly in situations when labeled data is limited or costly to acquire, the development of fast and effective few-shot learning techniques can help to create more flexible and versatile visual recognition systems. This has possible effects on society in fields including surveillance, medical image analysis, and autonomous systems where learning from few samples is absolutely essential.

It is crucial to recognize, nevertheless, the limits of this study. Based on a particular WOS-CC dataset, the study might not include all pertinent field articles. Moreover, the bibliometric approach emphasizes quantitative indicators and might not completely represent the qualitative features of the research, such the originality or potency of the suggested approaches. Future studies should solve these constraints by including data from other sources and performing more thorough content and quality of publication analysis. Furthermore, noted research gaps and developing ideas like the use of few-shot learning in particular visual identification tasks and the investigation of new methods like feature fusion present chances for more study. The knowledge acquired by this study helps to clarify the present state-of-the-art and possible directions for next developments. Researchers and practitioners must expand on these

results and investigate creative ideas that could fully utilize few-shot learning in the progress of visual recognition systems as the field develops. Learning from few samples is not only a technological difficulty but also a basic step in producing more intelligent, flexible, and human-like artificial vision systems.

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