



AI, Machine Learning, and Deep Learning in Indian Healthcare: Intellectual Property Trends and Insights (2010–2025)

Kaustubh Keer¹ and Anuja Bokhare^{2†}

¹Dr. Vishwanath Karad MIT-World Peace University Department of Computer Science, Pune, India

²School of Data Science, Symbiosis Skills and Professional University, Pune, India

Received: 20th June 2025; revised: 8th August 2025

The research offers data-driven insights into the intellectual property landscape of AI-powered healthcare innovation in India between 2010 and 2025, with a focus on advancements employing artificial intelligence (AI), machine learning (ML), and deep learning (DL). The analysis uses curated data from Scopus to investigate trends in patent filings, identify leading applications and inventors, and highlight recent technology sectors such as medical imaging, diagnostics, and predictive analytics. This research provides actionable insights into the structure of AI-healthcare innovation in India and offers a foundation for policymakers, investors, and researchers to navigate the evolving intellectual property landscape.

Keywords: Artificial Intelligence, Machine Learning, Deep Learning, Healthcare, Patents, Bibliometric Analysis, Data-Visualization

The deployment of AI, ML, and DL into healthcare systems represents a paradigm shift in medical research, diagnostics, patient care, and health infrastructure management. These technologies have ushered in a new era of intelligent healthcare solutions, including predictive analytics, individualized treatment planning, robotic surgery, and real-time disease surveillance. As a result, the number of intellectual property (IP) generated in this interdisciplinary subject has increased internationally, with India emerging as a major contributor, both in terms of research and patent activity.¹

This paper provides a bibliometric analysis of patents issued in India that use AI, ML, and DL approaches to address healthcare concerns. The investigation, which spans a 15-year period from 2010 to 2025, tracks the evolution of technical innovation using patent metadata such as titles, inventors, applicants, filing years, and connections. The focus on India enables a thorough understanding of home innovation ecosystems, local industrial capacities, and the nature of research collaboration across institutions, corporations, and individuals.

India's healthcare ecosystem, with its unique combination of high illness load, diversified demographics, and cost-sensitive markets, has encouraged the development of indigenous AI-driven

solutions. This bibliometric analysis is thus very topical, as it identifies patterns in patent filings that reflect the country's strategic priorities in health research. The collection comprises both granted and published patents from patent offices, with an emphasis on applications such as medical image processing, clinical decision support systems, remote monitoring, and AI-assisted diagnostics.²

Using structured patent data, the analysis provides practical insights for policymakers, entrepreneurs, academic researchers, and investors seeking to understand India's standing in the global health-tech innovation race. It also provides an empirical framework for projecting future paths in AI-powered healthcare and improving strategic intellectual property planning in India.

Literature Review

The convergence of artificial intelligence (AI), machine learning (ML), and deep learning (DL) with healthcare has triggered a significant wave of innovation across diagnostics, treatment workflows, and public health systems. In response to the growing implementation of data-driven medical tools, researchers have increasingly examined not only their technological dimensions but also the surrounding intellectual property (IP) frameworks. Bibliometric analyses and patent mapping methods are now widely employed to trace the diffusion of innovation,

[†]Corresponding author: Email: anuja.bokhare@gmail.com

pinpoint research clusters, and assess national-level policy interventions.^{3,4}

Globally, the majority of AI-related healthcare patents have emerged from countries like the United States and China, reflecting strong R&D ecosystems and strategic national investments. Patent trends demonstrate an upward trajectory since 2015, particularly in domains like deep learning-enabled medical imaging and AI-based disease detection.³ Although Indian contributions to healthcare AI are on the rise, few studies have conducted a dedicated patent-o-metric investigation in this context. Some studies have used fusion and network analysis techniques to show that healthcare is among the leading sectors for AI-related patents in India.⁴ However, these investigations have typically covered a broader technological spectrum and lacked a focused lens on the medical domain.

Other recent studies have examined emerging job roles and required skillsets linked to AI-driven healthcare evolution in India, with patents used to support larger labour market trends.⁵ Sector-specific analyses in pharmaceutical research have also highlighted that deep learning models play a pivotal role in drug repurposing and AI-supported diagnostics.⁶ Reinforcement learning and convolutional neural networks are frequently embedded in Indian patents in pharma and med-tech applications, but filings are disproportionately concentrated among startups and private firms, with limited input from public research bodies.⁷

Several studies have underscored how national legal and regulatory ecosystems influence AI patenting patterns, especially in healthcare. For instance, India's restrictive policies on software patentability have limited the growth of AI innovations related to diagnostics and informatics. This constraint has prompted many inventors and institutions to file with international bodies such as the USPTO, making it difficult to track Indian innovation solely through domestic databases.⁸ Global evaluations have revealed a surge in patent filings after 2016, with machine learning, deep learning, and neural network technologies showing strong representation across clinical support systems and radiological applications.¹ The expansion of such technologies globally provides crucial context for country-level studies focused on mapping domestic innovation capacities and their alignment with global trends.

Advancements in text analytics have led to the adoption of deep learning-based tools, such as BERT

embeddings and self-supervised learning, to mine and interpret patent metadata. These methods significantly outperform traditional keyword and classification-based approaches by uncovering semantic associations in unstructured textual data. Emerging clusters such as privacy-aware AI diagnostics, NLP-driven clinical systems, and IoT-integrated health devices have been revealed using this approach.⁹ Additional bibliometric and patent studies on digital medical devices like pulse oximeters confirm the increasing integration of AI into wearable technologies and monitoring tools.¹⁰ Further analysis of digital health patents between 2017 and 2021 reinforced the role of AI in diagnostics and monitoring, highlighting its potential for commercialization and clinical translation.¹¹ Medical big data and wearable device integration were explored in studies combining nearly 800 patents with scientific literature, emphasizing how structured patent data enables mapping of co-evolving healthcare technologies and innovation clusters.¹²

Dedicated patent-o-metric investigations have tracked the thematic evolution of AI across healthcare domains. Analyses based on IPC codes and citation networks have revealed that diagnostic imaging, robotic surgery, and algorithmic pathology are key innovation areas, but collaborative networks remain underdeveloped in many low- and middle-income nations.¹³ During the COVID-19 pandemic, bibliometric and text mining studies indicated a notable increase in patents related to diagnostic tools, disease forecasting, and contact tracing applications, with India contributing significantly through its health-tech startup ecosystem.¹⁴ Longitudinal analyses of deep learning publications and patents confirm exponential growth since 2007, particularly in healthcare imaging through convolutional neural networks.¹⁵ Earlier evaluations of machine learning literature also identified India's increasing role in the AI-healthcare space, particularly post-2015, with contributions from leading academic institutions and select industrial players.¹⁶

Recent bibliometric efforts have honed in on specific clinical domains such as intensive care, where AI has demonstrated significant potential for real-time patient monitoring and predictive decision-making. One such study identified a growing trend in patent filings focused on AI applications within ICUs, including early warning systems and remote monitoring technologies.¹⁷ This specialization may

also explain the thematic clustering observed in Indian patent records. Technological frontier mapping through patent citation network analysis has further revealed concentrated activity in AI-enhanced pathology, particularly in next-generation diagnostic systems. These insights underscore the utility of citation network methodologies for tracing innovation evolution, especially in regions like India where collaborative patent ecosystems are still emerging.¹⁸

The global response to the COVID-19 pandemic has also spurred a notable increase in healthcare-related AI patents, especially in diagnostics and telehealth. This trend was captured through landscape analyses that integrate patent data from international sources like WIPO and USPTO with academic publication records, thereby offering dual lenses on innovation dynamics.¹⁹ Forecasting approaches using International Patent Classification (IPC) codes and inventor network analyses have also pointed to rising contributions from Asian countries in areas such as robotic surgery and AI-based clinical decision-making.² More recent investigations have focused on patent growth in domains like radiology and mental health, highlighting the influence of academic-industrial collaboration and the emergence of digital startups across the Asia-Pacific region.²⁰ Keyword co-occurrence mapping of healthcare AI patents has further revealed recurring innovation clusters namely "machine learning," "telemedicine," and "decision support systems" signalling core areas of invention activity.²¹

In terms of methodology, several recent studies have adopted advanced bibliometric tools to dissect AI-healthcare patent landscapes. Techniques like co-word analysis, TF-IDF-based keyword clustering, and triple-network mapping have become standard for identifying thematic structures and research hotspots within large patent corpora.^{22,23} Visualization tools such as VOS-viewer and Biblio-metrics have facilitated the mapping of researcher affiliations, institutional collaborations, and domain-specific term clusters. Additionally, topic modelling algorithms like Latent Dirichlet Allocation (LDA) and BERTopic have proven valuable in extracting semantically cohesive themes from patent abstracts and titles, including AI diagnostics, robotic surgeries, and real-time imaging.^{24,9} While these tools have enhanced trend forecasting and innovation strategy, the majority of analyses have been globally or Western-centric. Indian contributions are often marginally

acknowledged, with limited exploration of jurisdictional filing behaviours, inventor-applicant linkages, or institutional collaborations.

Furthermore, existing literature largely overlooks the regulatory and infrastructural complexities that shape patent behaviour in India, particularly concerning the ambiguous legal status of algorithmic inventions. As a result, there is limited understanding of how India's policy landscape impacts the trajectory of AI-healthcare innovation. This study addresses these research gaps by conducting a comprehensive analysis of Indian healthcare patents related to AI over the past 15 years, focusing on thematic evolution, innovation concentration, and collaboration structures.

Materials and Methods

Data Source, Data Collection and Data Preprocessing

The dataset used in this analysis was obtained from the Scopus Patent Search and curated into a structured format in Excel. The dataset includes patents that specifically:

- Fall under healthcare domains (medical devices, diagnostics, treatment, informatics, etc.)
- Mention AI, ML, or DL in their abstracts, claims, or titles
- Patent publications were filed in India between 2010 and 2025
- Include column data such as:
 - Patent number
 - Applicant/Inventor
 - Application year
 - Abstract and title text
 - Patent Office

The dataset underwent the following preprocessing steps:

- Year Filtering: Only patents between 2010–2025 were retained.
- Geographic Filtering: Only patents specific to India were retained.

All data was extracted using following query in the Scopus advanced patent search option,

```
("artificial intelligence" OR "machine learning" OR "deep learning") AND ("telemedicine" OR "medical diagnosis" OR "health monitoring" OR "healthcare") AND (PUBYEAR > 2009 AND PUBYEAR < 2026) AND (AFFILCOUNTRY ("India" ))
```

Table 1 — Keywords used for analysis

Primary Keywords	AND	“Artificial intelligence” OR “machine learning” OR “deep learning” "telemedicine" OR "medical diagnosis" OR "health monitoring" OR "healthcare"
------------------	-----	--

Bibliometric Tools and Techniques

The analysis was conducted using a combination of Quantitative Bibliometric Techniques and Network Analysis using visualisation tools like Julius.ai for mapping patent publications across the years, tracing Patent Office for the patents, and for network analysis of Applicants/ Inventors.

Constraints and Scope

- **Geographic Constraint:** The analysis is limited to patents filed in India.
- **Technological Scope:** Focused on AI-related technologies, specifically machine learning and deep learning, as applied to healthcare.
- **Data Timeframe:** Only patents between 2010 and 2025 are considered.

Analytical Goals

The methodology was designed to answer the following questions:

1. What is the growth pattern of AI/ML/DL-related healthcare patents in India over the years?
2. Who are the most active patent applicants (academic, corporate, startups)?
3. What are the patterns of collaboration among Indian assignees?

As a result of the data collection process according to above methodology only 24 data entries were found, Therefore, PRISMA meta-analysis was not required.

Tools Used

1. Scopus is used to obtain and filter data with accordance to the constraints decided for research study further manually structured in MS Excel.
2. Julius.ai tool is used to obtain insights and statistics from the structured MS Excel file by programming python code to create graphical outputs.

Statistical Analysis

Table 1 states the keywords used in the query in the Scopus patent search for the analysis. This report summarizes a dataset of 24 patent records, focusing on patent applications and grants. The data includes key information such as the "Patent Name," the "Applicant / Inventor," the "Patent Office" (which is

consistently "United States Patent and Trademark Office Pre-Granted Publication"), the "Year" of the patent, and the "Patent Number."

The "Patent Name" column provides a brief description of the invention. The "Applicant / Inventor" column lists the names of the inventors and the associated organizations. The "Year" column indicates the year the patent was filed or granted, ranging from 2019 to 2025, with an average year of approximately 2021.58. The "Patent Number" is a unique identifier for each patent.

Number of Patents Published Per Year

2019: 2 patents were published.

2020: The number of patents published increased significantly to 7.

2021: The number of patents published decreased to 5.

2022: The number of patents published decreased to 2.

2023: The number of patents published remained stable at 2.

2024: The number of patents published increased to 5.

2025: The number of patents published decreased significantly to 1.

Figure 1 shows the line chart illustrates the yearly patent application trend from 2019 to 2025. The y-axis represents the number of patents, and the x-axis represents the year. From the results it is evident that there are no patents from the years before 2019.

Figure 2 presents a comparative overview of how AI-based patents are distributed across key technological domains, including healthcare, general artificial intelligence, telecommunications, and computer vision. The distribution highlights the central role of healthcare in India's AI innovation landscape, suggesting a significant strategic shift toward medical and health-focused applications of machine learning and deep learning.

Healthcare (Highest Volume)

Healthcare emerges as the leading domain for AI-related patent activity, indicating a strong alignment between national healthcare challenges and emerging AI solutions. Patents in this space predominantly focus on:

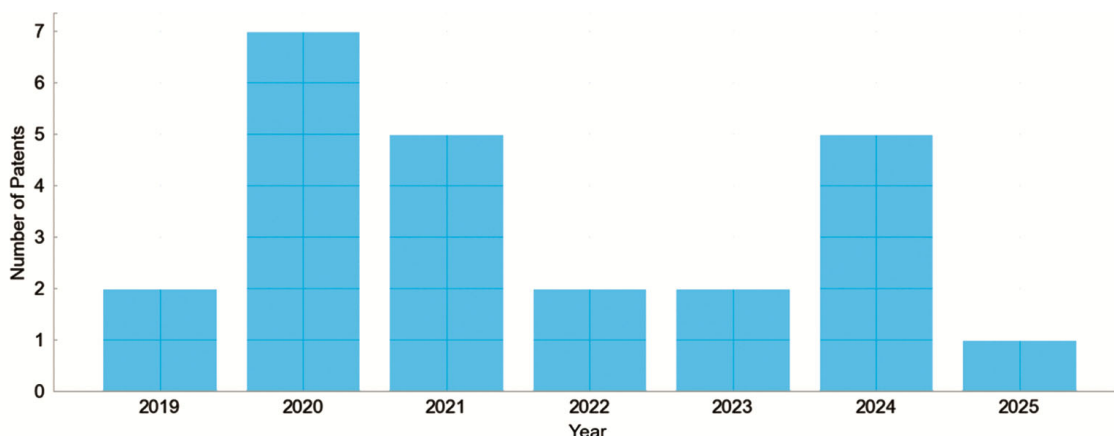


Fig. 1 — Number of patents published per year (2010-2025)

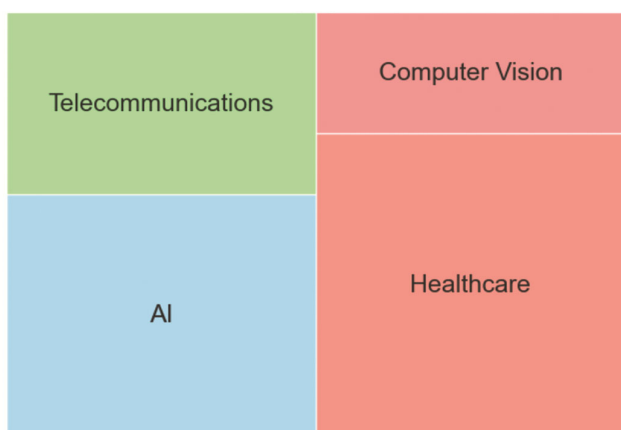


Fig. 2 — Patent Category Distribution

- Medical imaging
- Clinical decision support systems
- Remote diagnostics
- AI-driven patient monitoring

This trend reflects both the social demand for scalable healthcare solutions and the commercial opportunity created by India’s expanding digital health infrastructure.

Artificial Intelligence (General)

The second-largest category consists of patents classified under general AI frameworks, which include core algorithms, model optimization techniques, and cross-sector AI tools. These are foundational technologies that support downstream applications in various fields, including both healthcare and telecommunications.

Telecommunications

The telecom sector features prominently, though behind healthcare and general AI. AI innovations here are typically aimed at network optimization, 5G



Fig. 3 — Patent distribution across Patent Offices

predictive analytics, and automated fault detection—largely filed by major IT and telecom firms. This reflects India’s long-standing strength in telecommunications and the growing adoption of AI to modernize network infrastructure.

Computer Vision (Lowest Volume)

Although computer vision appears as the smallest category by patent volume, it plays a critical enabling role. Many patents in healthcare and telecom include computer vision components—for example, in medical imaging or surveillance automation—highlighting its value as a supporting technology rather than a standalone category.

Figure 3 shows a pie chart visually represents that the USPTO Pre-Granted Publication accounts for 100% of the patent distribution as per the data acquired. Although this study focuses on healthcare

innovation by Indian businesses, it is worth noting that all the evaluated patents were filed with the USPTO, not the Indian Patent Office. This jurisdictional choice illustrates a significant nuance in India's intellectual property framework, notably in software and algorithm-based breakthroughs. Section 3(k) of the Indian Patents Act states that computer programs "per se" are not patentable unless they are linked to novel hardware or have a demonstrable technological effect. This legal ambiguity has long been an impediment for innovators of artificial intelligence, machine learning, and software-driven healthcare devices, which frequently lack a tangible physical component. In contrast, the USPTO offers a clearer and more flexible environment for software and AI-related patents, making it the favoured filing location for Indian innovators seeking stronger legal protection and commercial gain. Furthermore, filing with the USPTO indicates an intention to enter worldwide markets, particularly in the United States, which remains a significant hub for AI-driven healthcare adoption. By recognizing this disparity, the study underscores the notion that India's patent law may require modification to boost local filings, particularly as digital health technologies become more vital to national healthcare strategy.

To overcome the obstacles of Section 3(k) in the Indian Patents Act, which currently limits the patentability of AI and software, a multi-faceted approach is essential. Firstly, legislative reform is paramount: Section 3(k) should be amended to clarify "computer programs 'per se'" and explicitly allow patentability for AI/ML and software that demonstrate a "technical character" or "technical contribution," moving away from the ambiguous "technical effect" and removing any mandatory novel hardware linkage. Secondly, the Indian Patent Office (IPO) must issue refined, detailed Computer Related Invention (CRI) Guidelines with numerous illustrative examples of patentable AI/software, coupled with intensive and ongoing training for examiners to ensure consistent application of these updated standards. Finally, the IPO should streamline its processes by facilitating pre-grant dialogue with applicants and considering specialized examination divisions for CRIs, while actively engaging with industry stakeholders to align patent policies with the rapid advancements in digital technologies.

Table 2 depicts 24 sets of Applicants/ Inventors corresponding to the organisations they are affiliated as per the acquired data from Scopus filtering in only the Indian applicants/ inventors in accordance to our research study.

Figure 4 exhibits the network diagram specifying the correlation between Indian authors, co-authors and their affiliated Indian organisations as our study targets innovations in India.

The co-author/inventor network depicted in Fig. 4 provides an important glimpse into the structural dynamics of healthcare AI innovation in India. The network shows a highly clustered structure centered on a few major businesses, namely Cognizant Technology Solutions, whose node is linked to numerous inventors, resulting in a dense, internally coherent cluster. This shows that corporate R&D teams work with repeat inventor groups, implying institutional continuity and possibly institutionalized IP generation pipelines. Startups like Digit7 India, Logistimo India, and Biofi Medical Healthcare, on the other hand, have smaller networks, with many one-time inventor affiliations and few cross-institutional relationships. These thinner structures indicate either early-stage innovation cycles or low resources for long-term patent collaboration.

Furthermore, the entire network has low inter-organizational density, with few ties connecting different organizations, indicating a fragmented innovation environment. The lack of academic or public-sector organizations in these networks underscores the notion that collaboration in India's AI-healthcare patent field is primarily compartmentalized, with resources concentrated within enterprises rather than across sectors. Notably, inventors such as Waghode, Nitesh Dattu, Pingle, and Amit Bindumadhav occur multiple times inside the same organizational cluster, emphasizing the importance of core technical leaders in driving patent continuity within companies.

These findings highlight the importance of collaborative platforms, such as shared patent labs or industry-academia consortia, that promote cross-pollination across institutional boundaries and between startups and corporations.

Table 3 states the applicant/ inventors from the Scopus patent search corresponding to number of patents published by them. Sr. No corresponding to the applicants/ inventors are used in the Fig. 4. On the x-axis for representation. It helps us determine

Table 2 — Applicants / Inventors and their corresponding organisations

Applicants / Inventors	Affiliated Organisation
Jagan, Balaji; Roy, Prasenjeet	Allstate India Private Limited
Dhamija, Amit; Sun, Kexuan	Rakuten Symphony India Private Limited
Bala, Erdem; Kitagawa, Koichiro; Muralidhara, Venkatesh K, Rajesh	Rakuten Mobile Usa Llc
Chandrashekar, Subramanya	E-Con Systems India Private Limited
Basu, Vijoy; Ramaraju, Ramprasad; Viveka Pruthiviraja, Joy K, Rajesh	Rakuten Symphony India Private Limited
Mani, Chithrai Selvakumar; Shukla, Gaurav	Cognizant Technology Solutions India Pvt. Ltd.
Maguluri, Surya Prakash; Rajendraprasad, Ravikumar; Ravikumar, Amutha Devi	E-Con Systems India Private Limited
Waghode, Nitesh Dattu; Diwanji, Vivek Vasant; Pingle, Amit Bindumadhav	Digit7 India Private Limited
Nagaraja, Negendra	Biofi Medical Healthcare India Private Limited
Meena, Chandrakant; Ramanujapuram, Arun	Cognizant Technology Solutions India Pvt. Ltd.
Upadhyay, Sandeep	Qpai India Private Limited
Joseph, Rajkumar; Gundimeda, Venugopal; John Luke, Jerubbaal	Logistimo India Private Limited
Jeevannavar, Satish Somayya	Cognizant Technology Solutions India Pvt. Ltd.
Joseph, Rajkumar; Gundimeda, Venugopal; John Luke, Jerubbaal	Cognizant Technology Solutions India Pvt. Ltd.
Waghode, Nitesh Dattu; Diwanji, Vivek Vasant; Pingle, Amit Bindumadhav	Ai Health Highway India Private Limited
Waghode, Nitesh Dattu; Diwanji, Vivek Vasant; Pingle, Amit Bindumadhav	Cognizant Technology Solutions India Pvt. Ltd.
Waghode, Nitesh Dattu; Diwanji, Vivek Vasant; Pingle, Amit Bindumadhav	Cognizant Technology Solutions India Pvt. Ltd.
Meena, Chandrakant; Ramanujapuram, Arun	Cognizant Technology Solutions India Pvt. Ltd.
Krishna Rao, Geelapaturu Subrahmanya Venkata Radha; Venkatachalam, Natarajan; Kulshreshtha, Anuj	Logistimo India Private Limited
Waghode, Nitesh Dattu; Diwanji, Vivek Vasant; Pingle, Amit Bindumadhav	Cognizant Technology Solutions India Pvt. Ltd.
Gokhale, Chandan; Rangamani, Sreenivas	Cognizant Technology Solutions India Pvt. Ltd.
Saravanabhavan, Hari; Balasubramanyam, Chandrasekhar	Cognizant Technology Solutions India Pvt. Ltd.
Krishna Rao, Geelapaturu Subrahmanya Venkata Radha; Venkatachalam, Natarajan; Kulshreshtha, Anuj	Cognizant Technology Solutions India Pvt. Ltd.

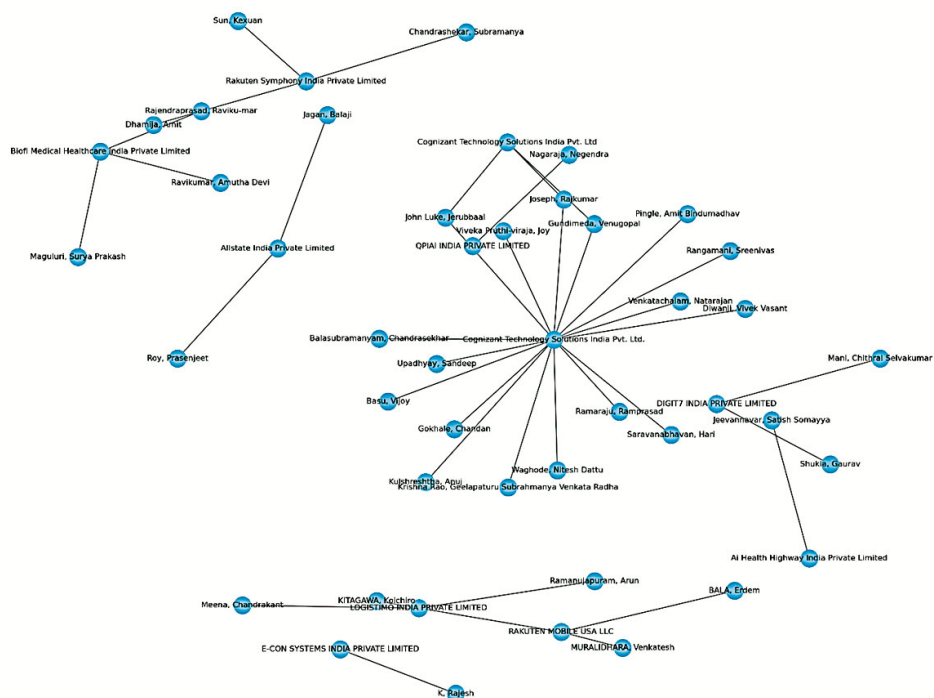


Fig. 4 — Author/ Co-author network graph

Table 3 — Applicants/ Inventors corresponding to number of patents

S. No	Applicant / Inventor	No. of Patents
1	Waghode, Nitesh Dattu; Diwanji, Vivek Vasant; Pingle, Amit Bindumadhav (...) (Cognizant Technology Solutions India Pvt. Ltd.)	4
2	Meena, Chandrakant; Ramanujapuram, Arun (Logistimo India Private Limited)	2
3	Krishna Rao, Geelapaturu Subrahmanya Venkata Radha; Venkatachalam, Natarajan; Kulshreshtha, Anuj (Cognizant Technology Solutions India Pvt. Ltd.)	2
4	K, Rajesh (E-Con Systems India Private Limited)	2
5	Jagan, Balaji; Roy, Prasenjeet (Allstate India Private Limited)	1
6	Dhamija, Amit; Sun, Kexuan (Rakuten Symphony India Private Limited (...))	1
7	Bala, Erdem; Kitagawa, Koichiro; Muralidhara, Venkatesh (...) (Rakuten Mobile Usa Llc (.))	1
8	Chandrashekar, Subramanya (Rakuten Symphony India Private Limited)	1
9	Basu, Vijoy; Ramaraju, Ramprasad; Viveka Pruthiviraja, Joy (...) (Cognizant Technology Solutions India Pvt. Ltd.)	1
10	Mani, Chithrai Selvakumar; Shukla, Gaurav (Digit7 India Private Limited)	1
11	Maguluri, Surya Prakash; Rajendraprasad, Ravikumar; Ravikumar, Amutha Devi (...) (Biofi Medical Healthcare India Private Limited)	1
12	Nagaraja, Negendra (Qpaii India Private Limited)	1
13	Upadhyay, Sandeep (Cognizant Technology Solutions India Pvt. Ltd.)	1
14	Joseph, Rajkumar; Gundimeda, Venugopal; John Luke, Jerubbaal (...) (Cognizant Technology Solutions India Pvt. Ltd.)	2
15	Jeevannavar, Satish Somayya (Ai Health Highway India Private Limited)	1
17	Gokhale, Chandan; Rangamani, Sreenivas (Cognizant Technology Solutions India Pvt. Ltd.)	1
18	Saravanabhavan, Hari; Balasubramanyam, Chandrasekhar (Cognizant Technology Solutions India Pvt. Ltd.)	1

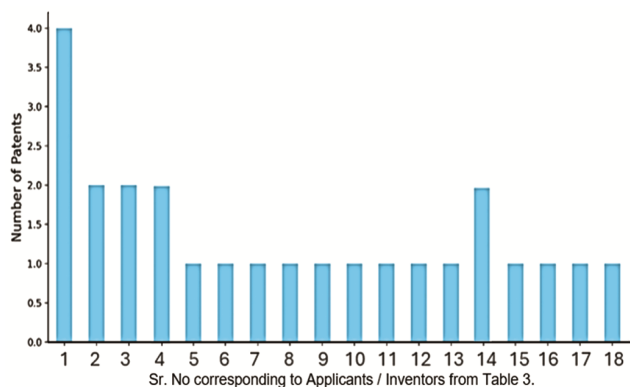


Fig. 5 — Number of patents by applicants/inventors

inventors / applicants who are consistently working on relevant studies with association to their affiliated organizations.

Figure 5 represents the number of patents published indicated on y-axis by applicants / inventors indicated by numbers corresponding to applicants/inventor's names and affiliations in table 2 on y-axis. Indicating that applicant with serial number 1 in the Table 3 have maximum of 4 published patents while serial number 2,3,4 and 14 have 2 patents each while rest have 1 patent published.

Discussion

This study does not use any form of specific analytical methodologies previously used for such bibliometric analysis like TF-IDF, LDA or BERT

based embedding as the dataset obtained after filtering with said constraints is relatively small and can easily be analysed by simple tools based on python programming. This bibliometric analysis of AI, machine learning, and deep learning-related healthcare patents registered in India between 2010 and 2025 demonstrates a dynamic and changing innovation environment. The annual patent filing trend from 2019 to 2025 exhibits significant oscillations, with a noticeable high in 2020, when seven patents were issued. However, by 2025 till date, there had been a dramatic reduction, with only one patent documented, presumably indicating a delay in publication or filings.

The study also finds that, while a few applicants and inventors have showed persistent engagement through several files, the majority have contributed only one patent, indicating a combination of focused and dispersed innovative activity. Importantly, 100% of the patents in the sample were filed using the USPTO Pre-Granted Publication, indicating a strong preference or requirement for international recognition and protection. Cognizant is by far the most prominent organization in this dataset. It has the highest number of inventor connections, involving at least 10+ unique inventors across multiple patents. This suggests a robust internal R&D infrastructure and an active role in patenting AI/ML-based healthcare innovations in India.

Overall, these findings shed light on the patterns of AI-driven healthcare innovation in India, emphasizing the importance of supporting domestic patent rules, ongoing R&D investment, and monitoring of overseas filing practices to guide strategic growth in this crucial sector.

Future study could broaden the scope of analysis by using full-text patent analysis, including claims and abstracts, to better understand the breadth and specificity of AI/ML/DL applications in healthcare. Incorporating data from jurisdictions other than the USPTO, particularly filings with the Indian Patent Office, would provide a more complete picture of domestic innovation trends. Furthermore, integrating patent data to clinical trial databases, startup ecosystems, and publication archives may provide more detailed insights into the translational impact of patented innovations. Longitudinal tracking of inventor networks and emergent subdomains, such as artificial intelligence in genomics or remote diagnostics, can aid in the prediction of innovation trajectory. Finally, more research into the effects of changing Indian intellectual property policies on AI-healthcare patents would be required to inform future innovation strategies and regulatory reforms.

The findings of this study have important implications for India's evolving intellectual property (IP) and innovation policy frameworks, particularly in the context of artificial intelligence applications in healthcare. First, the dominance of private-sector players, particularly multinational technology firms, and the near-complete absence of public research institutions or universities among patent filers indicate a significant imbalance. This highlights the importance of tailored incentives for public-sector R&D bodies and academic institutions conducting AI-healthcare research, such as intellectual property support schemes, patent filing grants, and commercialization help.

Second, the overwhelming preference for filing patents with foreign jurisdictions such as the USPTO rather than the Indian Patent Office demonstrates a lack of trust in India's current software patenting environment. The uncertain legal status of algorithm-based innovations under Section 3(k) of the Indian Patents Act continues to discourage applicants in domains such as machine learning, predictive modelling, and AI software platforms. A reform-oriented assessment of India's software patentability

requirements, potentially permitting algorithmic inventions with clear industrial applications in healthcare, might boost domestic registrations and assist local intellectual property growth.

Conclusion

The segregated nature of innovation, with little cross-institutional collaboration, indicates a greater need for national IP consortia and public-private patent accelerators. These frameworks can stimulate collaborative filings, lower expenses, and promote knowledge sharing. If effectively implemented, such policies have the potential to increase India's AI-healthcare IP base while also positioning the country as a global powerhouse for socially beneficial digital health innovation.

This study helps in determining the India's level of growth in AI based innovations in health sector over past decades. From these it be can conclude that there is enormous scope for improvements in AI based patent and innovation sector from innovation as well as ease in patent filing to nurture such Ai based developments in various fields especially including healthcare domain to contribute to advancements all over the world.

References

- 1 Guo Y, Hao Z, Zhao S, Gong J & Yang F, Artificial intelligence in health care: Bibliometric analysis, *Journal of Medical Internet Research*, 22 (7) (2020) e18228.
- 2 Benjamins S, Dhunoo P, Görög M & Mesko B, Forecasting artificial intelligence trends in health care: Systematic international patent analysis, *Journal of Medical Internet Research*, AI, 1 (1) (2023) e47283.
- 3 Oluwagbade E, Global perspectives on AI patenting in healthcare, *Research Gate*, (2025), available at: https://www.researchgate.net/publication/389465770_Global_Perspectives_on_AI_Patenting_in_Healthcare.
- 4 Kuniyil A, Kshitij A & Mandal K, Enhancing artificial intelligence policies with fusion and forecasting: Insights from Indian patents using network analysis, *arXiv*, (2023), available at: <https://arxiv.org/abs/2304.10596>.
- 5 George A S, George A S H & Baskar T, Artificial intelligence and the future of healthcare: Emerging jobs and skills in 2035, *Partners Universal Multidisciplinary Research Journal*, (2024), available at: <https://pumrj.com/index.php/research/article/view/2>.
- 6 Halagali P & Nayak D, Artificial intelligence revolution in pharmaceutical sciences: Advancements, clinical impacts, and applications, *Current Pharma Research*, (2025).
- 7 Kumar P, Chaudhary B, Arya P, Chauhan R & Devi S, Advanced artificial intelligence technologies transforming contemporary pharmaceutical research, *Bioengineering*, 12(4) (2025), available at: <https://www.mdpi.com/2306-5354/12/4/363>.

- 8 Sarkar A, Singh P & Varkey M, Healthcare artificial intelligence in India and ethical aspects, in *Reflections on Minds and Machines*, (Springer, 2024), available at: https://link.springer.com/chapter/10.1007/978-981-97-0503-0_7.
- 9 Evolution of AI-enabled healthcare systems using textual data with a self-supervised BERT-based model, *Science Report*, (2025), available at: <https://www.nature.com/articles/s41598-025-91622-8>.
- 10 Litvinova O, Hammerle F P, Stoyanov J & Ksepka N, Patent and bibliometric analysis of the scientific landscape of the use of pulse oximeters in digital medicine, *Healthcare*, 11(22) (2023) 3003, available at: <https://www.mdpi.com/2227-9032/11/22/3003>.
- 11 Gu W, Wang J, Zhang Y, Liang S, Ai Z & Li J, Evolution of digital health and exploration of patented technologies: Bibliometric analysis, *Interactive Journal of Medical Research*, (2024), doi:10.2196/48259.
- 12 Bai X *et al.*, Global quantitative analysis and visualization of big data and medical devices based on bibliometrics, *Expert System with Application*, (2024), available at: <https://www.sciencedirect.com/science/article/pii/S0957417424012648>.
- 13 Xin Y, Man W & Yi Z, The development trend of artificial intelligence in medical: A patentometric analysis, *Artificial Intelligence in the Life Sciences*, 1 (1) (2021) 100006.
- 14 Rodriguez-Rodriguez I & Rodriguez JV, Applications of artificial intelligence, machine learning, big data and the internet of things to the COVID-19 pandemic: A scientometric review using text mining, *International Journal of Environmental Research and Public Health*, 18 (16) (2021) 8578, available at: <https://www.mdpi.com/1660-4601/18/16/8578>.
- 15 Xu Z, Wang X & Li Y, A bibliometric analysis on deep learning during 2007–2019, *International Journal of Machine Learning and Cybernetics*, 11 (7) (2020) 1479, available at: <https://link.springer.com/article/10.1007/s13042-020-01152-0>.
- 16 Bhattacharya S, Some salient aspects of machine learning research: A bibliometric analysis, *Journal of Scientometric Research*, 8 (2) (2019) 85, available at: https://mail.jscires.org/sites/default/files/JScientometRes-8-2-s85_1.pdf.
- 17 Tang R, Zhang S, Ding C, Zhu M & Gao Y, Artificial intelligence in intensive care medicine: Bibliometric analysis, *Journal of Medical Internet Research*, 24 (11) (2022) e42185, available at: <https://www.jmir.org/2022/11/e42185/>.
- 18 Zhang T, Chen J, Lu Y, Yang X & Ouyang Z, Identification of technology frontiers of artificial intelligence-assisted pathology based on patent citation network, *PLoS ONE*, 17(8) (2022) e0273355, available at: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0273355>.
- 19 Mota F, Braga L A M, Cabral B P & Ferreira N C S, Examining the global patent landscape of artificial intelligence-driven solutions for COVID-19, *Machine Learning and Knowledge Extraction*, 6 (3) (2024) 78, available at: <https://www.mdpi.com/2504-4990/6/3/78>.
- 20 Kashani M & Dastani M, Evolution of artificial intelligence in medical sciences: A comprehensive scientometrics analysis, *Global Knowledge, Memory and Communication*, (2025), available at: <https://www.emerald.com/insight/content/doi/10.1108/GKMC-09-2024-0586/full/html>.
- 21 Almeida MI & Rosa A, Emerging trends of artificial intelligence in healthcare: A bibliometric outlook, *International Journal of Healthcare Technology and Management*, (2024), available at: <https://www.inderscienceonline.com/doi/abs/10.1504/IJHTM.2024.136548>.
- 22 A bibliometric analysis of the advance of artificial intelligence in healthcare research, *Frontiers in Medicine*, (2025), available at: <https://www.frontiersin.org/journals/medicine/articles/10.3389/fmed.2025.1504428/full>.
- 23 Aria M & Cuccurullo C, Bibliometrix: An R-tool for comprehensive science mapping analysis, *Wikipedia*, (2022), available at: <https://en.wikipedia.org/wiki/Bibliometrix>.
- 24 Mapping the bibliometrics landscape of AI in medicine: Methods for topic analysis and publication trends using PubMed data 2000–2022, *PubMed*, (2022), available at: <https://pubmed.ncbi.nlm.nih.gov/38064255/>.