



Use of Artificial Intelligence Algorithms in Indian Knowledge Systems: A Systematic Review

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Abstract. Indian Knowledge Systems (IKS) represent a vast, multidisciplinary body of knowledge developed over centuries in domains such as medicine, language, mathematics, stars, farming, and philosophy, will always be valuable to the world. With today's technological transformation through 'artificial intelligence' (AI), many researchers are now trying to use computational techniques to maintain, understand, and apply traditional Indian systems of knowledge to modern society. This paper is a comprehensive system-atic review of AI programs used in traditional Indian knowledge theories. The authors classify what is known about AI and traditional Indian knowledge into categories, create a framework for how these disciplines might be used together in the future, and describe the kinds of programs using AI to invoke Indian knowledge systems to develop the structure and behaviours of the AI system. They also identify some of the challenges of using these two kinds of knowledge to work together (e.g. no data/insufficient data; ambiguous meaning; no agreed-upon format; ethical concerns). The authors conclude by announcing some future directions (e.g. building explainable AI; developing knowledge graphs; and establishing inter-disciplinary frameworks to provide guidance for the continuing sustainable integration of AI with IKS).

Keywords: Artificial Intelligence, Indian Knowledge Systems, Machine Learning, Natural Language Processing, Ayurveda Informatics, Knowledge Graphs, Digital Humanities

1 Introduction

Artificial Intelligence (AI) is part of the field of computer science, which focuses on developing computers that can simulate human intelligence to complete tasks, make decisions, and solve problems. Modern AI technologies (e.g., chatbots, image generators) rely on high amounts of data and machine-learning algorithms for their ability to function[15]. Many of these AI tools will increase worker productivity; however, potential ethical concerns and job displacement may occur from developing and implementing these tools.

Key Aspects of AI:

- **Definition & Function:** Artificial intelligence (AI) mimics human cognitive processes as perception, learning, reasoning, and problem-solving. It focuses on developing systems that can recognise patterns and make predictions by learning from data.
- **Types of AI:**
 - **Narrow AI (Weak AI):** Designed for specific tasks (e.g., Siri, facial recognition, recommendation algorithms). Almost all current AI is Narrow AI.
 - **General Artificial Intelligence:** A form of AI that is capable of reasoning, learning, and applying its knowledge in multiple areas just like a human being..
- **Core Technologies:** Artificial neural networks, which mirror the human brain, form the basis of modern, advanced AI.
- **Impact on Work & Society:** AI is projected to impact ~40-50% of white-collar roles by automating tasks, requiring reskilling for a shift toward "human-centric" creative skills. It is actively transforming healthcare (diagnostics), transportation (autonomous vehicles), and daily life.
- **Risks & Ethics:** Key concerns include data bias leading to discrimination, the spread of misinformation, high energy consumption, and long-term existential risks, prompting calls for regulation.

Indian Knowledge Systems (IKS) encompass structured and experiential knowledge accumulated across centuries through scholarly traditions and oral transmission. Foundational texts such as the Vedas, Upanishads, Charaka Samhita, and Panini's Ashtadhyayi illustrate the depth and diversity of knowledge in domains ranging from healthcare to linguistics.

In parallel, Artificial Intelligence (AI) has evolved as a transformative technology capable of extracting patterns, learning representations, and enabling intelligent decision-making. The convergence of AI and IKS provides a unique opportunity to bridge traditional wisdom with modern computational paradigms.

This paper aims to:

- Systematically review AI techniques applied to IKS
- Develop a taxonomy of AI applications in IKS
- Identify research gaps and challenges
- Propose future directions for interdisciplinary integration

2 Literature Review

The use of Artificial Intelligence (AI) methods to analyze and evaluate traditional Indian wisdom in the context of Indian Knowledge Systems (IKS) has received a great deal of attention because the applications of these methods may create a

fusion/bridge of ancient wisdom with contemporary computational analysis[16]. IKS consists of a vast array of traditional practices, i.e., Ayurveda, yoga, Ayurveda, Sanskrit literature, and the preservation of the Indian culture, all of which contain enormous amounts of unstructured/variant data requiring the use of data processing techniques to effectively utilize this information[17]. Traditional analytical methods; e.g., Machine Learning (ML), Deep Learning (DL), Natural Language Processing (NLP) are commonly used for processing and analyzing IKS related to these traditional practices. There are multiple types of data that can be used for data acquisition within the Indian Knowledge System, such as textual data from manuscripts; audio data from chanting and oral traditions; and image data such as herbs, scripts, and artifacts[30]. Therefore, Optical Character Recognition (OCR) has become a central part of the process for digitizing handwritten and printed manuscripts, enabling them to be converted into machine-readable format for further processing [5]. Furthermore, through the use of Natural Language processing (NLP) techniques, there has also been a significant increase in the ability to interpret or extract semantic meaning from Sanskrit or other classical languages for the purposes of translating, summarizing, and extracting knowledge [6]. AI algorithms are being used for diagnosing diseases, classifying body types, and suggesting individualized treatments with high accuracy in predictive analytics [1], especially in the field of alternative medicine (Ayurveda). By using machine-learning algorithms to process both physiological measurements and behavioral information, machine-learning meets the requirements set forth by Ayurveda to create a holistic, personalized healthcare solution. When utilizing the methodology of Nadi Pariksha, or pulse diagnosis, doctors can apply AI via sensors to compare their observations with data collected by machine learning models to produce objective outputs from their examinations. There is also the use of deep learning methods for diagnosing certain diseases (primarily relating to images) through the analysis of the tongue and face. The use of AI for drug discovery using Ayurveda has also seen a significant increase. Here, machine learning finds bioactive compounds and predicts the therapeutic benefits of those compounds in order to speed up the process of drug development while maintaining the same drug formulation that has been used for centuries [1][4]. AI can aid in the area of recording and preserving oral tradition through speech processing applied to the sound of Vedic chants (by maintaining phonetic fidelity). The applications of AI as they relate to the IKS (Indian Knowledge Systems) are not limited to healthcare but extend to higher education and the preservation of culture with intelligent tutoring systems and large digital libraries to improve access to information and learning experiences. AI can also be used for the restoration and preservation of cultural artifacts, manuscripts, or other historical documents through the use of methods like image processing and 3D imaging. Challenges remain, however, because there are no standardized databases to begin with; there is a lack of annotated datasets to work from; we need interdisciplinary cooperation among domain experts, linguists, and AI scientists [1]. There are also ethical issues regarding the misuse and misrepresentation of traditional knowledge and the need for AI models which provide some form of explainable feedback. Recent studies have been conducted to highlight "Ayurveda Intelligence" as a way of combining AI with

holistic health care to improve diagnosis, treatment, and patient results [2]. Further, "Ayurgenomics is an emerging area of research combining genetic information with Ayurveda using machine learning to provide new opportunities for precision medicine [3]. While early research is providing some evidence of success, the majority of AI products used in IKS are still in the developmental phase and will require additional large-scale validation to be considered suitable for general use [4]. Future work should focus on creating standard organizations, developing clusters of various data types, and creating ethically responsible, transparent algorithm development. In conclusion, AI algorithms have the potential to revolutionize the digital preservation, analysis and dissemination of Indian Knowledge Systems and to support their continued use globally without losing any aspect of their original context or value [1][6].

Recent studies indicate growing interest in AI-driven analysis of traditional knowledge:

- AI in healthcare has demonstrated strong capabilities in predictive diagnostics and personalized medicine[10].
- NLP techniques have been applied to low-resource languages including Sanskrit, enabling parsing and semantic interpretation[13].
- Knowledge graphs and ontologies have been used to model complex relationships in domain-specific knowledge systems[14].
- Ayurveda research highlights the integration of traditional medicine with modern computational approaches[12].

Despite these advances, research in AI-driven IKS remains fragmented and requires systematic consolidation.

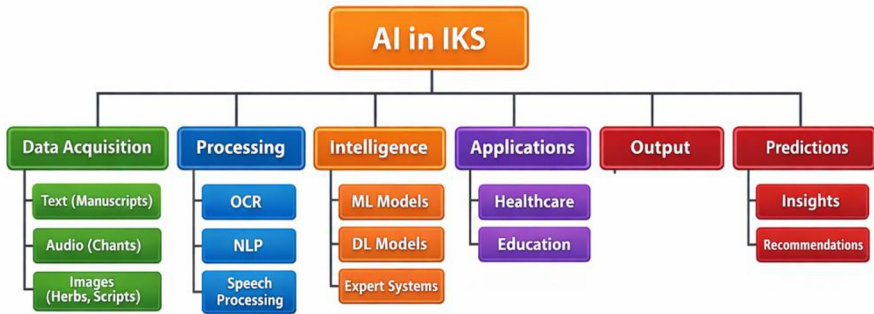
The Indian Knowledge System, a centuries-old tradition, has played an increasingly significant role in shaping Indian educational approaches and the modern artificial intelligence (AI) toolset that analyzes and predicts truth-based data. Although AI has become an increasingly popular decision-making process for research, education and forecasting purposes, it lacks the ethical principles defined in the ancient knowledge system. This research will demonstrate the historical connection between Indian Knowledge Systems (IKS) and Artificial Intelligence; how ancient Indian philosophical concepts from the Vedic, Upa-nishadic and Bhagavad Gita scriptures can serve as a framework to justify and guide AI developers in implementing ethical, moral and human-centric strategies for building the next generation of AI technology. With the rapid proliferation of new AI technology, questions regarding the ethical implications of their use and the impact they may have on society and humans has become of primary concern. Many values of the Indian Knowledge System (IKS), such as Dharma (duty), Ahinsa (non-violence) and Seva (selfless service), may serve as guiding principles for AI-based decision making. The goal of this research is to explain how to include Indian wisdom in the AI design process so that AI-based applications efficiently accomplish their tasks, while adhering to ethical principles, social justice and ecological balance. This paper will also provide methods to incorporate the principles of IKS into AI, as well as to create a bridge between the ancient ethical traditions and modern innovations in AI, Keywords: Indian

Knowledge Systems (IKS), Artificial Intelligence (AI), Ethics in AI, Dharma, Vedic Philosophy, Ahinsa, Ethical AI Development [1].

3. Taxonomy of AI in Indian Knowledge Systems

The figure titled “Comprehensive Taxonomy of AI in IKS (Indian Knowledge Systems)” presents a structured and hierarchical view of how artificial intelligence integrates with traditional knowledge domains by organizing the entire process into five major components: Data Acquisition, Processing, Intelligence, Applications, and Output, each of which plays a critical role in transforming raw traditional knowledge into meaningful, actionable insights. At the foundational level, Data Acquisition represents the collection of diverse forms of traditional knowledge, including textual data such as ancient manuscripts, scriptures, and historical documents that contain valuable insights into philosophy, medicine, and science; audio data such as chants, recitations, and oral traditions that preserve linguistic and cultural heritage; and image-based data such as herbal plant images, ancient scripts, symbols, and artifacts that visually represent traditional practices and knowledge systems. Moving to the next stage, Processing involves converting this raw and often unstructured data into a machine-readable and analyzable format through various computational techniques, including Optical Character Recognition (OCR), which is used to digitize and extract text from scanned manuscripts and handwritten documents; Natural Language Processing (NLP), which enables the understanding, interpretation, and contextual analysis of ancient and modern languages; and Speech Processing, which focuses on analyzing and transcribing audio data such as chants and spoken knowledge into structured textual forms. After processing, the Intelligence layer represents the core computational capability where AI models are applied to derive patterns, learn from data, and make decisions, including Machine Learning (ML) models that identify trends and relationships in structured data, Deep Learning (DL) models that handle complex data such as images and speech with higher accuracy and abstraction, and Expert Systems that emulate human expertise by applying rule-based reasoning to domains like Ayurveda, astronomy, and traditional medicine. Building upon intelligence, the Applications layer demonstrates how these AI-driven insights are utilized in real-world scenarios, particularly in Healthcare, where traditional medical knowledge like Ayurveda can be enhanced with predictive analytics and diagnosis support; in Education, where digitized manuscripts and intelligent tutoring systems can facilitate personalized and accessible learning of traditional knowledge; and in Cultural Preservation, where AI helps in safeguarding, restoring, and promoting heritage by digitizing artifacts, preserving languages, and reconstructing historical knowledge systems. Finally, the Output layer represents the end results generated by the system, including Predictions that forecast outcomes such as disease diagnosis or crop yield based on traditional practices, Insights that provide deep understanding and hidden patterns within the knowledge base, and Recommendations that offer actionable suggestions, such as personalized treatments or learning pathways. Overall, this taxonomy clearly illustrates a complete pipeline where traditional knowledge is

systematically collected, processed, analyzed, and transformed into intelligent outputs, highlighting the potential of AI to bridge the gap between ancient wisdom and modern technology while ensuring preservation, accessibility, and innovation in



Indian Knowledge Systems.

Figure 1 Comprehensive Taxonomy

4 AI Techniques in IKS

4.1 Machine Learning

Machine learning (ML) is a subfield of artificial intelligence (AI) where algorithms are trained on data to recognize patterns and make predictions or decisions without explicit programming. By analyzing vast datasets, these systems improve their accuracy over time, powering technologies like recommendation engines, image recognition, and generative AI.

Core Concepts and Types of Machine Learning

- Learning with supervision is when the training dataset consists of both inputs and outputs (labeled data), with the goal of inferring the classification or prediction of new data for application (e.g., spam detection, housing price prediction).
- Learning without supervision is examining a collection of data without any indication of classifications or predictions, in order to find hidden patterns or relationships among similar items (e.g., population groupings).
- Learning by reinforcement involves the agent making a number of choices to determine the optimal way to maximize its cumulative reward (e.g., using an agent to help assemble a robot or create a video game).
- Generative AI (G.A.I.) is a subcategory of machine learning and is used to improve or produce new data based on previously acquired knowledge (e.g., to generate new text or images).

4.2 Deep Learning

Inspired by the neural networks found in the human brain, deep learning is a specialised branch of machine learning that uses multi-layered artificial neural networks (ANNs) to analyse intricate patterns in unstructured data such as text, sound, and images. It powers modern AI applications, including voice assistants, autonomous vehicles, and facial recognition, by automatically learning features without manual feature engineering.

Key Aspects of Deep Learning

- **Neural Networks:** An input layer, several hidden layers, and an output layer make up these. "Deep" describes the numerous buried levels, which can number in the hundreds.
- **Learning Process:** Models are trained on massive datasets. They identify patterns by iteratively adjusting parameters (weights) through algorithms to minimize error in their predictions.
- **High Performance Needs:** Due to the complexity and data volume, deep learning typically requires powerful computing infrastructure, specifically GPUs, to handle the heavy computations efficiently.

Primary Types of Deep Learning Models

- **CNNs** are used for analyzing images and videos (also known as computer vision) such as identifying cancer in a medical scan or identifying an object.
- **RNNs/LSTMs** are well suited for sequential data and natural language processing (NLP) tasks like speech recognition, language translation, and chatbots (techniques that can use human language).
- **GANs** feature two networks that compete with one another by generating new instances of data (e.g., realistic images).
- **Transformers:** Power modern large language models like ChatGPT, excelling at processing massive text datasets and understanding context.

Applications of Deep Learning

- **Healthcare:** Medical imaging for disease diagnosis and drug discovery.
- **Autonomous Systems:** Self-driving cars for obstacle detection and navigation.
- **Natural language processing** includes voice-activated assistants, sentiment analysis, and real-time translation.
- **Computer Vision:** Face recognition and surveillance systems

Deep learning has become prominent due to the surge in big data availability and advancements in computational hardware, allowing for more accurate predictions without human intervention.

4.3 Natural Language Processing

NLP techniques are critical for:

- Sanskrit grammar parsing
- Machine translation
- Semantic analysis

5. Knowledge-Based Systems

The Indian Knowledge System (IKS) refers to the collective body of wisdom, traditions, and practices originating from the Indian subcontinent over thousands of years. It covers diverse fields—including philosophy, science, technology, medicine, and arts—rooted in ancient literature like the Vedas and Upanishads. IKS promotes a holistic, sustainable lifestyle.

Key Components of IKS:

- **Fundamental Texts:** Based on Vedic literature, Vedas, Upvedas, and philosophical treatises (Vedanta, Yoga, Nyaya, etc.).
- **Fields of Study:** Encompasses agriculture, medicine (Ayurveda), architecture, mathematics, astronomy, linguistics, and arts
- **Core Characteristics:**
 - **Holistic Approach:** Fosters harmony between humans and nature.
 - **Experiential Learning:** Derived from observation and experience.
 - **Sustainable Living:** Focuses on ethical practices and sustainable development.
- **Modern Relevance:** The Ministry of Education and NEP 2020 encourage incorporating IKS into education to promote cultural continuity, critical thinking, and ethical leadership.

Key Areas of Study:

- **Science and Engineering:** Ancient contributions to metallurgy, mathematics, and architecture.
- **Life Sciences:** Ayurveda and health practices.
- **Arts and Humanities:** Indian literature, music, dance, and traditional crafts.

- Philosophy and Psychology: Vedantic studies and yogic



Figure2 Relation of AI to Indian knowledge system with diagrams

Artificial Intelligence (AI) serves as a modern tool to digitize, analyze, and scale the Indian Knowledge System (IKS), strengthening cultural identity and sustainability, while IKS provides an ethical, holistic framework to guide responsible AI development. The synergy combines ancient wisdom with computational efficiency, spanning fields like education, agriculture, and healthcare.

Core Areas of Integration

- **Ethical AI (Dharma-Centric):** Using IKS principles like Karma (action) and Dharma (duty) to address modern AI issues of bias and accountability.
- **Cultural Preservation:** Using AI technologies such as Virtual Reality (VR) and machine learning to preserve and digitize ancient manuscripts, arts, and languages.
- **Sustainability & Agriculture:** Applying traditional knowledge on ecology and crop management alongside modern AI predictive analysis for sustainable farming.
- **Personalized Education:** Merging Guru-Shishya tradition (individualized mentorship) with AI-powered adaptive learning to improve educational outcomes.

Key Parallels and Applications

- **Holistic Knowledge:** Both systems are interdisciplinary, drawing insights from diverse fields such as psychology, logic, and mathematics.
- **Intelligent Systems:** AI aids in building smart systems (e.g., IoT, robotics) for agriculture and manufacturing that are aligned with sustainability.

- Challenges: The integration faces challenges in data scarcity, cultural sensitivity, and translating qualitative traditional knowledge into digital formats.

6. AI-Based Architecture for IKS



Figure 3 Layered Architecture

The pipeline consisting of Data Layer → Preprocessing → Feature Extraction → AI Models → Knowledge Base → Applications represents a comprehensive and systematic framework widely used in modern artificial intelligence systems, especially in interdisciplinary domains such as healthcare, agriculture, and Indian Knowledge Systems (IKS). The Data Layer serves as the foundational component where raw data is gathered from diverse sources such as structured databases, sensor networks, historical manuscripts, digital libraries, and multimedia repositories [18]. This layer is critical for ensuring data availability, scalability, and integration, while also addressing issues such as redundancy, inconsistency, and noise [19]. In IKS, data may include ancient Sanskrit texts, Ayurvedic formulations, astronomical observations, and ecological records, making data diversity a significant challenge [20].

Pre-processing is an essential process in preparing raw data for analysis[7]. It validates that the data is of good quality before proceeding into the next analysis stage[8]. The goal of this transformation process is to produce a clean version of the data set by correcting or removing invalid data values, reducing noise, normalizing the data, and establishing consistency between each data point in the raw data set [21]. Quality Data is critical for achieving accurate results during analysis, therefore quality data maintenance will ensure that any subsequent Analytical Process performed on this data is also reliable and accurate [22]. Pre-processing can utilize a number of different techniques such as cleaning data, creating tokens from text, removing or replacing certain words (stemming), and converting the data into electronic representation (encoding) [23]. Proper pre-processing will aid in the

effectiveness of Machine Learning Models and reduce the amount of computational resources required to create the Model [24].

Feature Extraction is a crucial stage where meaningful attributes or patterns are derived from the preprocessed data [25]. This step reduces the dimensionality of data while preserving its essential characteristics, enabling efficient learning by AI models [26]. Methods such as Principal Component Analysis (PCA), feature selection, and embedding techniques are commonly used [27]. In the context of IKS, feature extraction may involve identifying semantic patterns in ancient texts, extracting medicinal properties from herbal datasets, or recognizing astronomical cycles from traditional observations [28]. This stage bridges raw data and intelligent modeling by converting complex information into structured representations [29].

Various algorithms use the AI Models stage of the underlying computational structure to perform data analysis and produce output [30]. Machine learning, deep learning, and natural language processing techniques are all used in model-based activities such as classification, prediction, clustering, and pattern recognition [31]. Common examples of these models are: neural networks, decision trees, support vector machines, and transformer-based architectures like BERT and GPT [32]. The quality of the extracted features and the quality and rigor of the preprocessing steps can significantly affect how well these models will perform [33]. Following this, the Knowledge Base acts as a structured repository for storing learned information, rules, relationships, and domain-specific insights [34]. It enables reasoning, inference, and knowledge reuse across different applications [35]. In IKS, knowledge bases may include structured representations of Ayurveda, yoga practices, Vedic mathematics, and traditional ecological knowledge [36]. This layer supports semantic understanding and facilitates integration between traditional wisdom and modern computational intelligence [37].

Finally, the Applications layer represents the real-world implementation of the entire pipeline, where insights derived from AI models and knowledge bases are used to solve practical problems [38]. Applications include decision support systems, recommendation systems, intelligent tutoring systems, healthcare diagnostics, and smart agriculture solutions [39]. In the IKS domain, applications may involve AI-driven Ayurvedic diagnosis systems, automated translation of ancient Sanskrit texts, and predictive models for sustainable farming practices [40]. These applications demonstrate the transformative potential of combining AI with traditional knowledge systems [41].

The pipeline is iterative in nature, meaning feedback from applications can be used to refine earlier stages such as preprocessing, feature extraction, and model training [42]. Continuous learning ensures adaptability to new data and evolving requirements [43]. Additionally, ethical considerations such as data privacy, bias reduction, and transparency must be maintained throughout the pipeline to ensure responsible AI deployment [44].

In conclusion, the Data Layer → Preprocessing → Feature Extraction → AI Models → Knowledge Base → Applications pipeline provides a robust and scalable framework for developing intelligent systems [45]. Each stage contributes significantly to the overall efficiency, accuracy, and reliability of the system [46]. The integration of this pipeline with Indian Knowledge Systems opens new avenues for preserving cultural heritage while leveraging advanced AI technologies [47]. This approach not only enhances data-driven decision-making but also promotes sustainable and inclusive innovation across multiple domains [48].

7. Domain-Specific Applications

7.1 Ayurveda

Ayurveda is one of the most prominent domains within Indian Knowledge Systems where AI is creating transformative impact[9]. AI models enable disease prediction by analyzing patient data such as symptoms, lifestyle, and historical medical records to identify potential health risks at an early stage. Machine learning algorithms can detect patterns that may not be visible to human practitioners, improving diagnostic accuracy. In terms of personalized treatment, AI systems recommend individualized therapies based on a person's body constitution (Prakriti), dietary habits, and environmental factors, aligning closely with Ayurvedic principles. Additionally, AI supports drug discovery by analyzing herbal compositions, identifying active compounds, and predicting their effectiveness, thereby accelerating the development of new Ayurvedic formulations.

7.2 Sanskrit NLP

Sanskrit processing through AI, commonly known as Natural Language Processing (NLP), is a growing research area. Grammar modeling using rule-based systems is particularly effective because Sanskrit follows highly structured grammatical rules defined by ancient scholars like Panini. AI systems replicate these rules to analyze sentence structure and syntax accurately[11]. Furthermore, machine translation and text generation techniques allow automatic conversion of Sanskrit texts into modern languages and vice versa. This helps in digitizing and preserving ancient manuscripts while making them accessible to a global audience. Advanced AI models can also generate meaningful Sanskrit sentences, supporting educational and research applications.

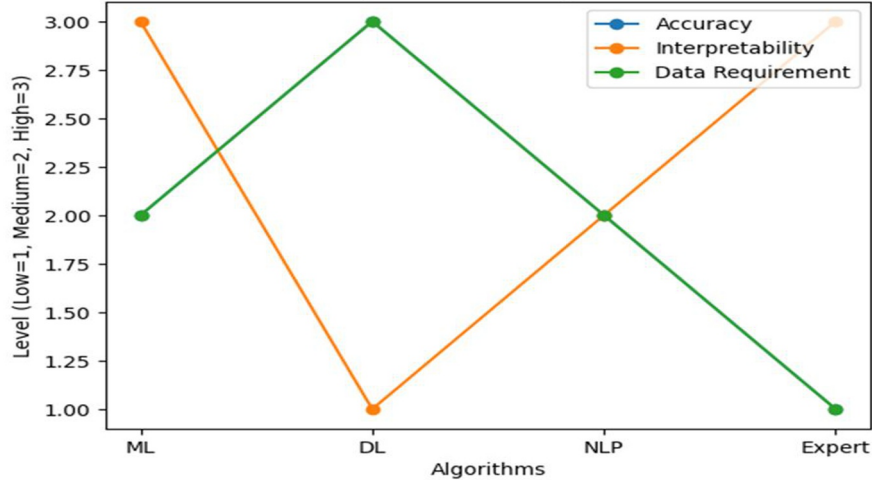
7.3 Yoga and Wellness

Yoga and wellness applications are increasingly enhanced through AI technologies. Pose detection using computer vision allows systems to analyze body posture in real-time using cameras and sensors, providing feedback to improve accuracy and prevent

injuries during yoga practice[16]. This is widely used in smart fitness applications. Additionally, AI contributes to mental health prediction by analyzing behavioral data, speech patterns, and physiological signals to detect stress, anxiety, or depression. These systems can recommend meditation, breathing exercises, and lifestyle adjustments, aligning with holistic wellness approaches rooted in traditional practices.

7.4 Astronomy and Mathematics

Ancient Indian contributions to Astronomy and Mathematics are being revisited using AI techniques. Simulation of ancient astronomical models allows researchers to recreate historical theories related to planetary motion, eclipses, and time calculation using computational tools. This helps validate traditional knowledge with modern scientific understanding. Moreover, pattern recognition in historical data enables AI



systems to analyze ancient manuscripts, numerical patterns, and mathematical formulations, uncovering hidden insights and relationships. These applications bridge the gap between historical knowledge and contemporary science, fostering deeper understanding and innovation.

8. Comparative Analysis

Figure 4 Comparison of AI Algorithms

The line graph above presents a comparative visualization of four major AI approaches— Natural Language Processing (NLP), Deep Learning (DL), and Machine Learning (ML), and Expert Systems—across three important parameters: Accuracy, Interpretability, and Data Requirement. The values are represented on a normalized scale where Low = 1, Medium = 2, and High = 3, allowing a clear visual comparison of their relative strengths and limitations.

Machine Learning (ML) shows a medium level of accuracy, indicating that it performs well for structured and moderately complex problems but may struggle with highly unstructured data. However, ML has high interpretability, meaning its models (like decision trees or linear regression) are easier to understand and explain, which is crucial in domains like healthcare and finance. Its moderate data requirement makes it practical for applications where massive datasets are not available.

Deep Learning (DL), on the other hand, demonstrates high accuracy, making it the most powerful among the four approaches, especially for complex tasks such as image recognition, speech processing, and advanced predictions. However, it has low interpretability, often referred to as a “black box,” where understanding how decisions are made becomes difficult. Additionally, DL requires high amounts of data, which can be a limitation in domains where data is scarce or expensive to obtain.

Natural Language Processing (NLP) occupies a balanced position in the graph, with medium accuracy, medium interpretability, and moderate data requirements. NLP techniques are specifically designed to handle human language and are widely used in applications such as translation, chatbots, and sentiment analysis. While modern NLP models can be complex, many approaches still maintain some level of explainability.

Expert Systems show a contrasting trend with low accuracy but high interpretability and low data requirements. These systems rely on predefined rules and knowledge bases rather than learning from data. Because of this, they are highly transparent and easy to understand but lack adaptability and may not perform well in dynamic or complex environments.

The graph clearly highlights a trade-off between accuracy and interpretability. As we move from Expert Systems to Deep Learning, accuracy increases but interpretability decreases. Similarly, higher-performing models like DL demand more data, which increases computational and resource requirements.

This comparison is particularly important in the context of Artificial Intelligence system design, where choosing the right algorithm depends on the application requirements. For example, in critical domains like medicine or law, interpretability may be more important than accuracy, favoring ML or Expert Systems. In contrast, applications like image recognition or autonomous driving prioritize accuracy, making DL more suitable.

Overall, the graph provides a clear understanding of how different AI techniques balance performance, transparency, and data dependency, helping researchers and practitioners select the most appropriate approach for their specific problem domain.

9. Challenges

The integration of artificial intelligence into Indian Knowledge Systems faces several significant challenges that can be broadly categorized into technical, conceptual, and ethical dimensions. From a technical perspective, one of the major issues is the lack of structured datasets, as much of the traditional knowledge exists in unstructured formats such as manuscripts, oral traditions, and ancient scriptures. These sources are often handwritten, fragmented, or preserved in non-digital forms, making it difficult

to convert them into machine-readable datasets suitable for AI applications. Additionally, the presence of noise, inconsistencies, and missing information further complicates data preprocessing and analysis. Another critical technical challenge is the issue of low-resource languages, particularly classical languages like Sanskrit and regional dialects, which lack large annotated corpora required for training modern machine learning and NLP models. This limitation restricts the performance and scalability of AI systems in understanding and processing traditional knowledge effectively.

From a conceptual standpoint, one of the most complex challenges is the contextual interpretation of ancient texts. Traditional knowledge systems are deeply rooted in cultural, philosophical, and symbolic meanings, which are often difficult to interpret using purely computational methods. AI models may struggle to capture the nuances, metaphors, and implicit knowledge embedded in ancient scriptures, leading to incomplete or inaccurate interpretations. Moreover, many texts are written in highly structured grammatical forms or poetic styles, requiring domain expertise in addition to computational techniques. This creates a gap between technological capabilities and the depth of traditional knowledge understanding.

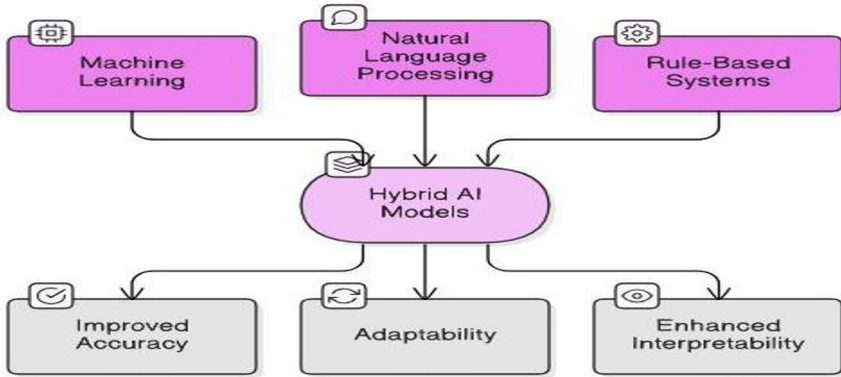
Ethical challenges also are essential to the use of AI in IKS. One major concern is cultural sensitivity, as traditional knowledge is closely tied to cultural identity, heritage, and community values. Misrepresentation, misinterpretation, or commercialization of such knowledge without proper understanding can lead to cultural disrespect or loss of authenticity. Another important issue is intellectual property rights, where questions arise regarding ownership, access, and usage of traditional knowledge. Since much of this knowledge has been collectively developed over generations, defining legal ownership becomes complex. There is also a risk of exploitation, where organizations may use traditional knowledge for commercial purposes without providing fair recognition or benefits to the originating communities.

In addition to these challenges, there is a need for interdisciplinary collaboration between technologists, historians, linguists, and domain experts to ensure accurate and respectful integration of AI with traditional knowledge systems. Addressing these issues requires the development of standardized datasets, improved language resources, culturally aware AI models, and robust ethical frameworks. Furthermore, government policies and institutional support are essential to promote responsible innovation in this field. Overall, overcoming these challenges is critical for leveraging AI to preserve, enhance, and disseminate traditional knowledge while maintaining its authenticity, cultural significance, and ethical integrity.

10. Future Directions

The Figure 5 Future Research Framework highlights a progressive roadmap for advancing Indian Knowledge Systems using modern AI techniques. It begins with Explainable AI, which ensures that AI systems are transparent and their decisions can be understood by humans. This is crucial for trust and adoption, especially in

culturally sensitive domains. The next stage involves Knowledge Graphs, which structure complex relationships between concepts, enabling better representation of traditional knowledge. These graphs help in linking diverse datasets and improving semantic understanding. Moving forward, Hybrid AI Models combine rule-based



systems with machine learning approaches to balance interpretability and accuracy. Such models are particularly effective in handling both structured and unstructured knowledge. Finally, the framework leads to Global IKS Platforms, which aim to create unified digital ecosystems for sharing, preserving, and accessing traditional knowledge worldwide. This layered approach ensures scalability, interoperability, and cultural preservation. Overall, the framework provides a clear direction for future research by integrating transparency, structured knowledge, intelligent modeling, and global accessibility.

Figure 5 Hybrid AI Models

Future research should focus on:

- Explainable AI
- Multilingual NLP
- Open datasets
- Interdisciplinary collaboration

11. Conclusion

The integration of Artificial Intelligence with IKS represents a cultural paradigm shift toward digital humanities and knowledge-driven innovation. AI enables:

- Systematic preservation of heritage
- Scientific validation of traditional knowledge
- Global accessibility

However, sustainable progress requires collaboration between technologists and domain experts.

This paper discusses AI (Artificial Intelligence) applications within Indian Knowledge Systems. The findings of the evaluation show that AI can increase the accessibility of traditional knowledge, validate traditional knowledge, and apply traditional knowledge. Addressing the ethical issues surrounding traditional knowledge and AI will be critical to the continued success of AI in Indian Knowledge Systems.

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