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## AI- BASED CROP RECOMMENDATION FOR FARMERS

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### Abstract

Agriculture is essential to the economy, but farmers often face challenges in selecting the right crop due to unpredictable climate and limited soil knowledge. This AI-Based Crop Recommendation System uses machine learning (Random Forest Classifier) to analyze soil nutrients and weather conditions to suggest the most suitable crop. A Flask-based web application provides easy and secure access, along with an AI-powered agricultural chatbot for instant guidance. The system helps improve crop yield, reduce financial risk, and promote sustainable farming practices.

**Keywords:** AI-Based Crop Recommendation ,Machine Learning , Random Forest Classifier ,Smart Agriculture ,Soil Nutrient Analysis ,Weather Prediction ,Flask Web Application ,Agricultural Chatbot , Crop Yield Optimization , Sustainable Farming

### Introduction

Agriculture is the backbone of many economies, especially in developing countries like India, where a large portion of the population depends on farming for their livelihood. The productivity of crops depends on several factors such as soil nutrients, weather conditions, rainfall, and proper farming practices. Traditionally, farmers rely on experience, seasonal patterns, or local advice to decide which crop to cultivate. However, due to climate change, soil degradation, and unpredictable weather, traditional methods often lead to poor crop yield and financial losses.

With the rapid advancement of Artificial Intelligence (AI) and Machine Learning (ML), data-driven approaches can significantly improve decision-making in agriculture. By analyzing soil and environmental data, machine learning models can accurately predict suitable crops for specific conditions. In addition, AI-powered expert systems can assist farmers by providing instant guidance related to crop care, pest control, and best agricultural practices. This project introduces an AI-Based Crop Recommendation System integrated with an Intelligent Farming Expert Assistant, offering farmers a smart, reliable, and easy-to-use platform for making informed agricultural decisions.

Traditional and existing crop recommendation systems suffer from several limitations that reduce their effectiveness for farmers: Crop selection is mostly based on experience and guesswork, not scientific analysis Many systems provide generic recommendations without considering real-time soil and weather conditions Lack of machine learning models, resulting in low prediction accuracy No secure login or user management system Absence of interactive expert support for farmers Limited accessibility due to complex interfaces No integration of AI-based advisory systems These drawbacks often lead to poor crop yield, financial loss, and inefficient use of resource.

## 1. Literature Survey

Apat et al. (2023) proposed a machine learning-based crop recommendation system using CatBoost with parameters like N, P, K, pH, rainfall, temperature, and humidity. The model achieved around 99.5% accuracy and showed strong performance with balanced data. However, it is limited to a single-region dataset and lacks weather API integration.

Sharma et al. (2023) developed a deep learning-based crop recommendation system integrating soil (pH, NPK) and weather data. It provides accurate predictions and automates feature extraction. However, it requires large datasets and has high training time.

Turgut et al. (2024) introduced an explainable AI-based crop recommendation system using LIME, SHAP, and ELI5. It uses soil, climate, and geographic data to provide transparent and interpretable decisions. However, it has a complex setup and depends heavily on large datasets.

Shastri et al. (2025) proposed a gradient boosting model combined with explainable AI for crop recommendation. It uses soil nutrients and environmental factors to achieve high accuracy (about 99.27%). However, it is computationally intensive and not suitable for mobile applications.

## 2. Methodology

### a. Data Collection

The methodology begins with the acquisition of an agricultural dataset comprising soil nutrients such as Nitrogen, Phosphorus, and Potassium, along with environmental parameters including temperature, humidity, pH, and rainfall.

### b. Data Preprocessing

The collected dataset is preprocessed by handling missing values, eliminating inconsistencies, and transforming the data into a structured format suitable for machine learning applications.

### c. Model Training

A Random Forest Classifier is employed for training the model, enabling it to learn relationships between input features and corresponding crop outputs.

### d. Model Integration

The validated model is integrated into a web-based application using the Flask framework to facilitate real-time crop prediction.

### e. User Input Processing

The system accepts input parameters through a web interface, where the data is validated and transformed into a format compatible with the trained model.

**f. Crop Prediction**

The processed input is provided to the trained model, which generates predictions for the most suitable crop based on the given conditions.

**g. Result Display**

The predicted output is presented to the user through the interface in a clear and interpretable manner.

**h. AI Expert Chat Integration**

An AI-based chatbot module is incorporated to provide domain-specific agricultural guidance and respond to user queries effectively.

### 3. Algorithm

**1. Random Forest Classifier (Crop Recommendation Algorithm)**

- The algorithm creates a collection of multiple decision trees during training.
- Each decision tree learns different patterns from the agricultural dataset.
- When input data is provided, each tree gives its own prediction.
- The final crop recommendation is selected based on the most commonly predicted crop among all trees.

**2. Flask-Based Prediction Pipeline (Web Integration Algorithm)**

- Accepts soil and weather values from the web form.
- Converts user inputs into a format suitable for the trained ML model.
- Sends the processed data to the loaded crop prediction model.
- Receives the predicted crop and displays it on the web page.

**3. Gemini AI-Based Expert Chat Algorithm (Intelligent Advisory System)**

- Uses a strict system instruction to limit responses to agriculture only.
- Rejects unrelated queries such as entertainment, coding, or politics.
- Ensures domain-specific and reliable responses

### 4. Results

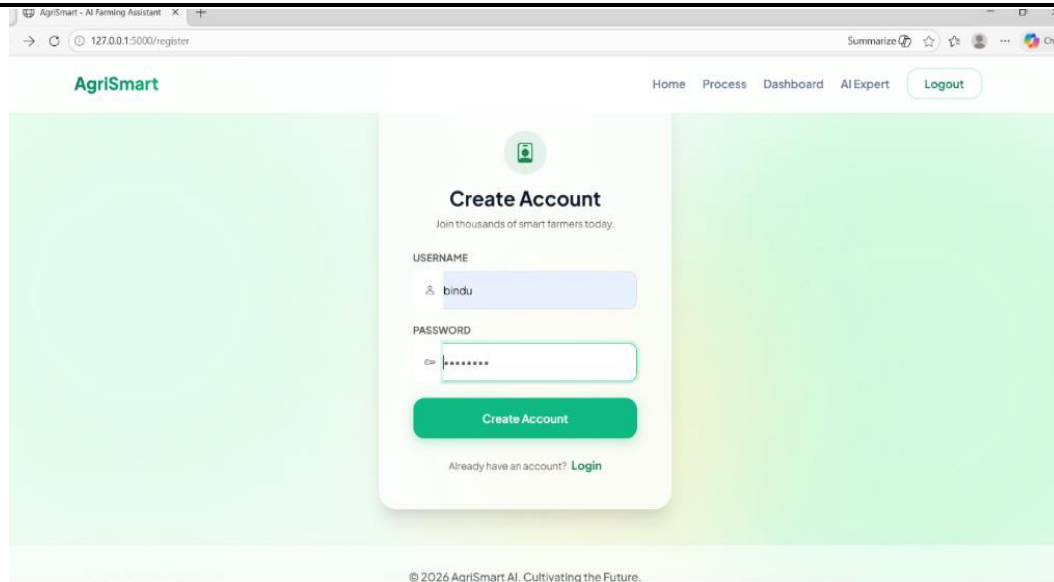


Fig 1: Login page

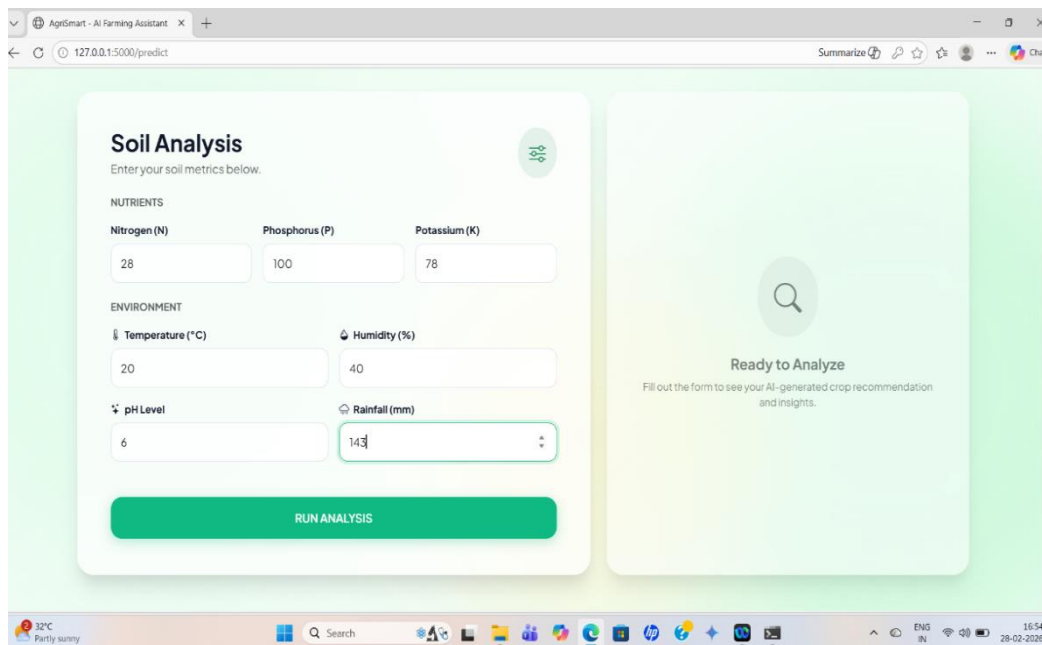


Fig 2:

Enter the soil parameters

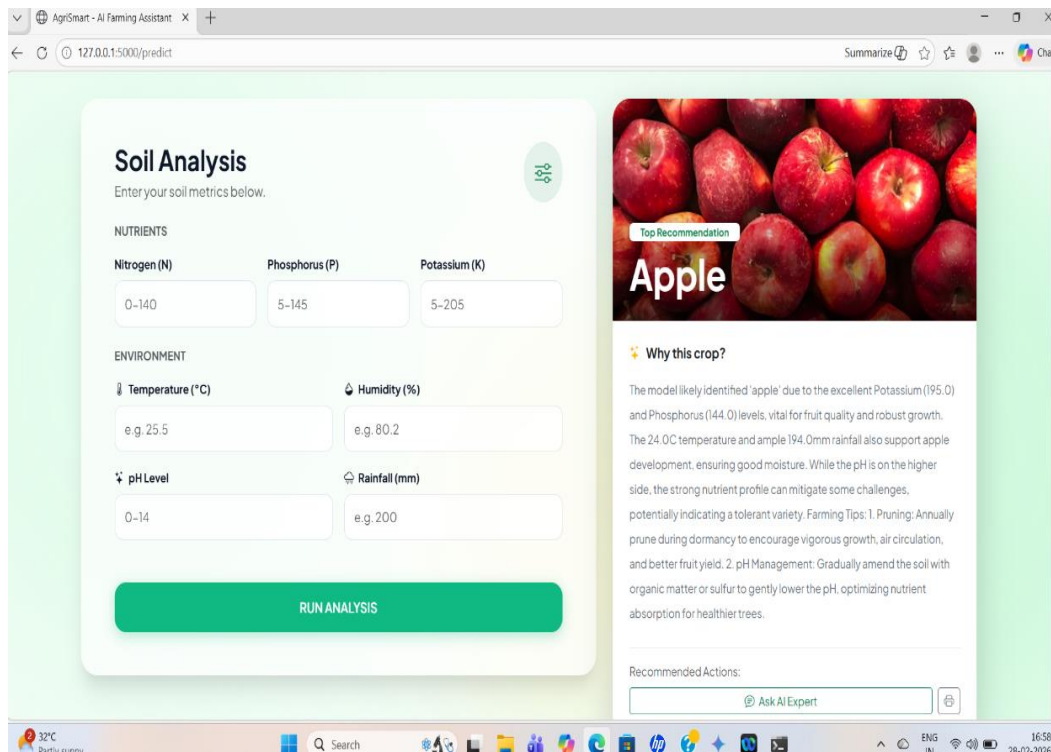


Fig 3: predicting the crop

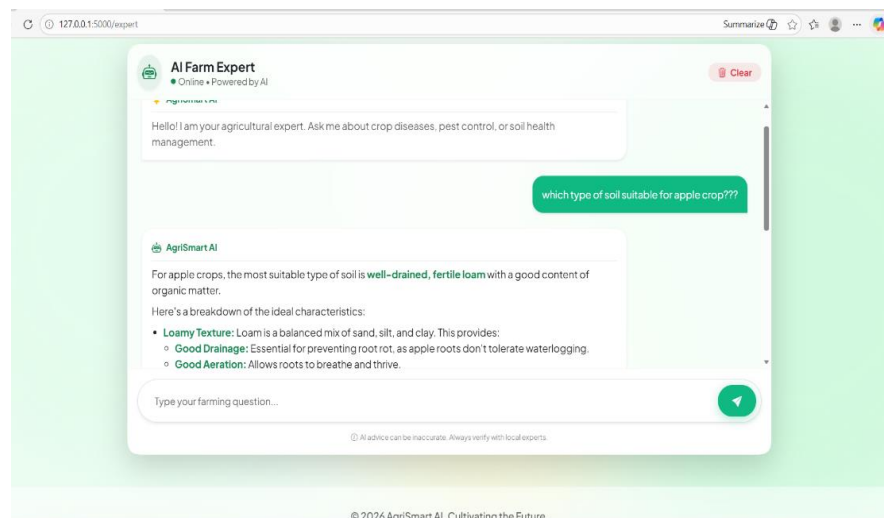


Fig 4: AI-chatbot

## 5. Conclusion

AI-Based Crop Recommendation System uses machine learning to help farmers select suitable crops based on soil nutrients and environmental conditions. The Random Forest algorithm analyzes factors like Nitrogen, Phosphorus, Potassium, pH, temperature, humidity, and rainfall to give accurate crop recommendations. A Flask-based web application allows farmers to easily interact with the system. The project also includes an AI-powered chatbot using Google Gemini to provide farming guidance. Overall, the system supports smart farming and better agricultural decision-making.

## 6. Future Scope

The proposed AI-Based Crop Recommendation System can be enhanced by integrating real-time weather data and IoT-based soil sensors to improve prediction accuracy. The development of a mobile application would increase accessibility for farmers. Additional features such as fertilizer recommendation, pest and disease detection, and crop yield prediction can further extend system capabilities. Improving the chatbot with multilingual support and integrating government schemes and market information would make the system more effective. Overall, these improvements can transform the system into a scalable and efficient smart farming solution that supports sustainable agriculture.

## 7. References

1. S. Shastri, Advancing Crop Recommendation System with Supervised Machine Learning, *Scientific Reports*, 2025 — A study on ML-based crop recommendation using soil and environmental data for improved productivity.
2. H. Gunasekaran, Leveraging Machine Learning for Smarter Agricultural Decision-Making, *MDPI*, 2024 — Proposes ML-based crop recommendation using Kaggle agricultural dataset of soil and weather parameters.
3. B. Ramesh Naidu, Harvest Harmony: Integrating ML Models for Precision Crop Recommendation, *ResearchGate*, Nov. 2024 — A comparative study of linear and nonlinear models for crop prediction.
4. M. Arefin, AGRO AI: Personalized AI Recommendations for Soil Quality and Crop Selection, *ScienceDirect*, 2026 — Focuses on multi-source AI for real-time soil assessment and agricultural decision support.
5. Crop Recommendation System Using Machine Learning, *International Journal ISSRET*, 2025 — Covers integrated crop, disease, and fertilizer recommendation using ML and DL approaches.
6. Crop Recommendation System Using Machine Learning (RF, SVM, KNN), *MDPI*, 2025 — Evaluation of various ML algorithms for crop recommendation with real datasets.
7. Multi-criteria Agriculture Recommendation System using Machine Learning, *Agriculture Journal*, 2023 — Proposes multi-feature crop and fertilizer recommendation model with soil and economic factors.

8. AI-Powered Agritech Chatbot: Democratizing Access to Agriculture Expertise, IJSRET (2025) — Discusses the benefits of AI chatbot systems in delivering farming guidance to users.
9. D. Shanthi, "Smart Water Bottle With Smart Technology", Handbook Of Artificial Intelligence, Bentham Science Publishers, Pg. No: 204-219, 2023.
10. P. K. Bolisetty And Midhunchakkaravarthy, "Comparative Analysis Of Software Reliability Prediction And Optimization Using Machine Learning Algorithms," 2025 International Conference On Intelligent Systems And Computational Networks (ICISCN), Bidar, India, 2025, Pp. 1-4, Doi: 10.1109/ICISCN64258.2025.10934209.
11. Shanthi, Dr. D., G. Ashok, Chitrika Biswal, Sangem Udharika, Sri Varshini, and Gopireddi Sindhu. 2025. "Ai-Driven Adaptive It Training: A Personalized Learning Framework For Enhanced Knowledge Retention And Engagement". Metallurgical and Materials Engineering, May, 136-45. <https://metall-mater-eng.com/index.php/home/article/view/1567>.
12. Shanthi, D., Aryan, S. R., Harshitha, K., & Malgireddy, S. (2023, December). Smart Helmet. In International Conference on Advances in Computational Intelligence (pp. 1-17). Cham: Springer Nature Switzerland.
13. Shanthi, D., G. Narsimha, and R.K. Mohanthy. 2015. Human Intelligence vs. Artificial Intelligence. International Journal of Electronics Communication and Computer Engineering 6 (5): 30–34.
14. D. Shanthi, Narla Swapna, Ajmeera Kiran, and Shaga Anoosha, Ensemble approach of GP, ACOT, PSO, and SNN for predicting software reliability, International Journal of Engineering Systems Modelling and Simulation Vol. 15, No. 2, March 1, 2024pp 68-75.
15. D. Shanthi, R. K. Mohanty, G. Narsimha and V. Aruna, "Application of partial swarm intelligence technique to predict software reliability," 2017 International Conference on Intelligent Computing and Control Systems (ICICCS), Madurai, India, 2017, pp. 629-635, doi: 10.1109/ICCONS.2017.8250539.
16. D. Shanthi, P. Kuncha, M. S. M. Dhar, A. Jamshed, H. Pallathadka and A. L. K. J E, "The Blue Brain Technology using Machine Learning," 2021 6th International Conference on Communication and Electronics Systems (ICCES), Coimbatre, India, 2021, pp. 1370-1375, doi: 10.1109/ICCES51350.2021.9489075.
17. Shanthi, D., C. H. Sankeerthana, and R. Usha Rani. "Spiking Neural Networks for Predicting Software Reliability." ICICNIS. 2020. 179-185.
18. D. Shanthi, R. K. Mohanty and G. Narsimha, "Application of Machine Learning Techniques for Stastical Analysis of Software Reliability Data Sets," 2018 Second International Conference on Intelligent Computing and Control Systems (ICICCS), Madurai, India, 2018, pp. 1472-1474, doi: 10.1109/ICCONS.2018.8663005.
19. P. Endla, A. R, S. Suneel, A. P. Singh, P. A and D. Shanthi, "MedSensePathway: A Hybrid Framework for Real-Time Diagnosis of Malarial Parasites using Medical Imaging," 2025 9th International Conference on Electronics, Communication and Aerospace Technology (ICECA), Coimbatore, India, 2025, pp. 1972-1978, doi: 10.1109/ICECA66444.2025.11382939.
20. Shanthi, D. (2022). Smart Healthcare for Pregnant Women in Rural Areas. In Medical Imaging and Health Informatics (eds T.H. Jaware, K. Sarat Kumar, R.D. Badgujar and S. Antonov). <https://doi.org/10.1002/9781119819165.ch17>

21. Todupunuri, A. (2025). IMPROVING CUSTOMER EXPERIENCE WITH MODERN BANKING SOLUTIONS. SSRN Electronic Journal. <https://doi.org/10.2139/ssrn.5120615>
22. Babburi, S. (2024). Explainable AI Framework for Policy-Compliant Anomaly Detection in Data Pipelines.
23. Gaddam, S. Integrating Analytics into the Development Process: Bridging the Gap between Data Insights and Design Execution.
24. Reddy, S. K. R. Developing a Modular AI Framework to Enhance Scalability and Personalization in Next-Generation Reward Platforms.
25. Poojari, R. INTELLIGENT SYSTEMS+B108 AND APPLICATIONS IN ENGINEERING.
26. Vasagam, M. (2024, August 30). Ensuring security in modern data pipelines: Practical strategies for data engineers. *International Journal of Intelligent Systems and Applications in Engineering*, 12(22s), 2401.
27. Santthosh Saai Reddy Purmani. (2026). Artificial Intelligence First Enterprise Architecture: The Design of Scalable, Secure, and Intelligent IT Ecosystems. *American Journal of AI Cyber Computing Management*, 6(1(2)), 1–8. [https://doi.org/10.64751/ajaccm.2026.v6.n1\(2\).pp1-8](https://doi.org/10.64751/ajaccm.2026.v6.n1(2).pp1-8)
28. Cyril, H. P., & Kumara, S. (2026, February). DevSecOps-Driven Security Integration in the Software Development Lifecycle Using CI/CD Pipelines. In 2026 IEEE 5th International Conference on AI in Cybersecurity (ICAIC) (pp. 1-6). IEEE.
29. Kotte, G. (2025). Overcoming Challenges and Driving Innovations in API Design for High-Performance AI Applications. SSRN Electronic Journal. <https://doi.org/10.2139/ssrn.5283649>
30. Mahtabi, M., Roshan, M., Muhit, M. M. I., Behvar, A., & Haghshenas, M. (2026). Cryogenic ultrasonic fatigue: Mechanisms, advancements, and insights. *Cryogenics*, 153, 104257. <https://doi.org/10.1016/j.cryogenics.2025.104257>
31. Viswanathan, V. (2024). Pioneering Ethical AI Integration in Enterprise Workflows: A Framework for Scalable Team Governance. Available at SSRN 5375619.
32. Akhilaiswarya, B., Sree, B. T., Lilly, K., Chowdary, K. H., & Sruthi, M. (2023). Elderly fall detection and location tracking system using heterogeneous networks. *Journal of Engineering Sciences*, 14(05).
33. Viswanathan, V. (2025). Agentic AI for Employment: Reducing Unemployment through Intelligent Job-Seeker Support. *LEX LOCALIS—Journal of Local Self-Government*.
34. Mudusu, S. K. (2026, February 9). AI-augmented data quality engineering. InfoWorld (Foundry Expert Contributor Network).
35. Viswanathan, V., Shah, A. K., Kubam, C. S., Dontu, S., Gandhi, A., & Singla, P. (2025, August). Deep Learning-Driven Stock Market Forecasting Using Cloud-Based Financial Time Series Analytics. In 2025 International Conference on Emerging Trends in Networks and Computer Communications (ETNCC) (pp. 1-6). IEEE.
36. Sruthi, M. V., Soundararajan, K., & Sree, V. U. (2012). Accurate Multimodality Registration of medical images. *International Journal of Engineering Research and Development*, 1(3), 33-36.
37. Viswanathan, V., Polagani, S. S., Agarwal, R., Akula, S., Dey, S., & Kashyap, R. (2025, September). AI-Augmented Threat Intelligence for Proactive Intrusion Detection in Multi-

- 
- Cloud Ecosystem. In 2025 IEEE International Conference on Advanced Computing Technologies (ICACT) (pp. 567-572). IEEE.
38. Mudusu, S. K., & Gentyala, S. (2026). Zero-Trust Data Pipelines for AI Systems: A Framework for Secure, Verifiable, and Auditable Data Engineering. *JOURNAL OF RECENT TRENDS IN COMPUTER SCIENCE AND ENGINEERING (JRTCSE)*, 14(2), 10-25.
39. DEVARASETTY, N. (2023). SCALABLE DATA ENGINEERING APPROACHES FOR AI-DRIVEN INDUSTRIAL IOT APPLICATIONS. *INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH AND MANAGEMENT*, 11(06), 954-968.
40. Agrawal, A. M., Gajula, S., Shinde, R. P., Shah, H., & Ghosh, H. (2025, July). Machine Translation for Long Sequences with Enhanced Attention Mechanisms. In 2025 5th International Conference on Electrical, Computer and Energy Technologies (ICECET) (pp. 1-6). IEEE.
41. Dayal, P. S., Chandra, B. R., Keerthi, M., Sruthi, M., Venkatesh, K., Appalaraju, G., & Eswari, G. (2013). Design of Pyramidal Horn Antenna at 10GHz Using WIPL-D Optimizer. *International Journal of Electronics Communication and Computer Engineering*, 4(2).
- Maturi, S. Y. (2023). Crowdsourced frontier: Unveiling autonomous adversarial cybercapabilities via open AI competition. *International Journal of Intelligent Systems and Applications in Engineering*, 11(1s), 275–284.
42. Hassan, T., Karim, M. F., Jeelani, H., Behnam, E., Green, R., & Syed, F. J. (2025). Optimizing Medical Question-Answering Systems: A Comparative Study of Fine-Tuned and Zero-Shot Large Language Models with RAG Framework. arXiv preprint arXiv:2512.05863.
43. Manoharan, D. (2026). Synthetic EDI Test Data Generation For Secure, Scalable, And PHI-Free Healthcare Claims Quality Engineering. *Journal of International Crisis and Risk Communication Research*, 9(1).
44. Ravishankara, M. (2026, February). CircuChain: Disentangling Competence and Compliance in LLM Circuit Analysis. In SoutheastCon 2026 (pp. 1-7). IEEE.
45. Sruthi, M. V., Sree, V. U., & Soundararajan, K. (2012). Specific removal of motion artifacts in medical image processing. *IJECCE*, 3(3), 227-229.