



Application of Natural Language Processing in Agricultural Decision Support Systems

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Introduction

Agriculture remains a vital pillar of the global economy, particularly in developing regions where it significantly contributes to employment and Gross Domestic Product. However, farmers frequently face numerous challenges, including limited access to professional advisory services, inadequate knowledge of modern agricultural techniques, and a lack of real-time data on crop management, pest control, weather conditions, and market dynamics. To address these barriers, the integration of Natural Language Processing (NLP) into agricultural advisory systems offers a transformative opportunity. This study presents the development of E-Agro, an intelligent chatbot system powered by NLP, designed to provide real-time, accessible, and context-aware support to farmers, especially in rural and underserved areas.

Methodology

The E-Agro system was developed through a multi-phase methodology encompassing system analysis, design, implementation, testing, and deployment. During the analysis phase, information was gathered via interviews and focus groups to identify farmers' needs. The design phase involved creating the system architecture, user interface prototypes, and selecting appropriate NLP models, particularly transformer-based models such as BERT and GPT-2. The development phase implemented these models using Python, TensorFlow, Flask, and integrated APIs for weather and agricultural databases. System testing included unit, integration, and user acceptance tests. Finally, the chatbot was deployed on cloud-based platforms and tested in real-world environments.

Results and discussion

Initial testing revealed that E-Agro effectively addresses frequent agricultural queries, including topics on pest control, crop rotation, and climate conditions. The chatbot demonstrated strong performance in delivering accurate and timely responses, enhancing decision-making efficiency among users. Farmers appreciated the system's ease of use, multilingual support, and real-time feedback. However, some limitations were noted: responses to highly specific or regionally contextual queries were less precise, indicating the need for additional localised training data. Furthermore, challenges related to internet access and digital literacy were observed in rural deployments, suggesting future development of offline-compatible versions and simplified interfaces. Despite these challenges, user feedback was overwhelmingly positive, and iterative improvements were implemented based on observed usage patterns.

Conclusion

The E-Agro intelligent chatbot system underscores the transformative role of NLP in agricultural extension services. By offering real-time, contextually relevant, and user-friendly support, the system empowers farmers to make informed decisions, thereby enhancing productivity and food security. The project validates the feasibility and scalability of NLP-driven solutions in agriculture and highlights the importance of continual system updates, multilingual capabilities, and user-centric design. Future work should explore integrating additional AI features such as image recognition and predictive analytics to further enhance E-Agro's capabilities. The adoption of such intelligent systems has the potential to bridge the information gap in agriculture and support sustainable development goals in rural communities.

Keywords: Natural Language Processing (NLP), Intelligent Chatbot, Agricultural Advisory System, E-Agro, Real-Time Support