AI in Agriculture and Ethical AI Development

Minor in AI

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1   Transformative AI Applications in Agriculture

> **Real-World Impact Case Studies**
>
> **Case 1: Phenobot System**
>
> - **Problem:** Manual crop monitoring (2 hours/acre) vs AI solution (5 minutes/acre)
>
> - **Solution:** $100 IoT device with Raspberry Pi + U-Net segmentation
>
> - **Outcome:** 40% faster identification of drought-resistant crops
>
> **Case 2: See & Spray Technology**
>
> - **Problem:** 70% herbicide waste in traditional spraying
>
> - **Solution:** Real-time ML weed detection
>
> - **Outcome:** 90% chemical reduction (Blue River Tech)

In today's rapidly evolving technological landscape, artificial intelligence (AI) is transforming traditional industries, particularly agriculture. Consider a farmer who deploys a low-cost IoT device called a *phenobot* to monitor crop health. This device captures images of crops, which are then analyzed using AI techniques to detect issues such as pest infestations, water stress, or nutrient deficiencies in real time.

2   AI in Agriculture: Solving Real-World Problems

2.1   The Problem

Traditional farming methods face several challenges:

- Inefficient resource management

- Late detection of crop diseases and pests

- Difficulty in predicting optimal harvest times

- Environmental concerns due to overuse of chemicals

- Labor-intensive and time-consuming manual inspections

- Prone to human error and inconsistent data collection

2.2   How AI Addresses the Problem

AI offers compelling solutions through:

1. **Precision Farming:** AI-powered equipment uses sensors and GPS to optimize planting, watering, and fertilizing.

2. **Crop Monitoring:** Computer vision and machine learning analyze crop health, enabling early detection of issues.

80% time rule on domain and data
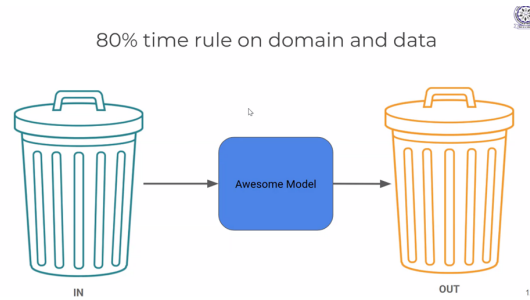
3. **Predictive Analytics:** AI algorithms analyze various data sources to predict weather patterns and crop yields.

4. **Automated Pest Control:** AI-driven systems can identify and target pests with precision, reducing chemical use.

5. **Image Analysis with Deep Learning:** Implementing segmentation models such as U-Net to analyze images and extract meaningful traits (e.g., leaf size and health).

3   AI Development Principles

3.1   Thumb Rules for AI Model Building

> **Dr. Praveen's 80/20 Principles**
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> 1. **80% Time on Data:** Allocate 80% of time for domain understanding and data preparation.
>
> 2. **20% Time on Models:** Reserve 20% of time for model building and refinement.
>
> 3. **80% Accuracy MVP:** Aim for an initial accuracy of 80% for MVP development.
>
> 4. **Hybrid Approach:** Use minimal labeled data effectively and consider hybrid approaches.
>
> 5. **Sustainability First:** Optimize for energy efficiency.

3.2   Ethical Considerations

- **Asimov Updated:** AI should benefit all ecosystems, not just humans.

- **Green AI:** A 10MB model running on solar beasts 10GB cloud model.

- **Explainability:** Farmers must trust and understand predictions.

- **Environmental Impact:** Evaluate and minimize the environmental footprint of AI systems.

- **Fairness:** Ensure the technology benefits a broad spectrum of stakeholders.

5 thumb-rules to building and deploying models

1. Spend 80% of your time on understanding the domain; cleaning, preparing and insights into the data (EDA)
2. Spend less than 20% of your time in building and refining the model!
3. MVP: Spend 80% of that 20% time in building a model that gives at least 80% accuracy (or Error of 20%) in the wild rather than 99% accuracy in validation set!
4. Spend only 20% of the 20% model building time in making it accurate!
5.
    a. Less labeled data -> rely on prior knowledge or science-based models or rule-based models.
    b. More labeled data -> consider yourself very lucky (go for deep learning)!
    c. Are you in-between? -> Hybrid approach (data + science models)

Figure 1: Enter Caption

4   Key Takeaways

- Data quality beats model complexity

- Start with explainable models

- Every AI system has environmental costs

- Cross-disciplinary knowledge is crucial

- AI enhances decision-making in farming through data-driven insights

- Precision agriculture enabled by AI optimizes resource use and reduces waste

- AI contributes to sustainable farming practices by reducing chemical usage and environmental impact

5   Conclusion

AI in agriculture represents a significant leap forward in addressing food security and sustainability challenges. By enabling precision farming, improving crop monitoring, and optimizing resource use, AI is helping farmers increase productivity while reducing environmental impact. As technology continues to evolve, we can expect even more innovative applications of AI in agriculture, further transforming the way we grow and manage our food resources.