Potato Blight Disease in Sri Lankan Farms

Disease Overview, Impact, Identification, and AI-Based Detection

Understanding Potato Blight

Potato blight, primarily caused by the *oomycete Phytophthora infestans*, is a devastating disease affecting potato crops globally. It infects leaves, stems, and tubers, leading to significant yield losses. The disease thrives in cool, moist environments, with optimal conditions being temperatures between 12–18°C and high humidity levels. In Sri Lanka, the central highlands, particularly Nuwara Eliya and Badulla districts, provide favorable conditions for the proliferation of late blight.

Severity and Economic Impact in Sri Lanka

Late blight remains one of the most economically significant diseases affecting potatoes globally, causing annual crop losses estimated at up to 15% of global potato production.

In Sri Lanka, potato cultivation is concentrated in the central highlands, with Nuwara Eliya and Badulla districts being the primary production areas. However, the country's potato production faces several challenges, including diseases like late blight, which significantly impact yields. According to a study, weather conditions, poor storage facilities, and varying availability of quality seed potatoes are major factors limiting potato production in Sri Lanka.

The economic impact of late blight is further exacerbated by the country's reliance on imported seed potatoes, which can constitute up to 50% of the production cost. This dependency increases vulnerability to disease outbreaks and market fluctuations.

Identification of Potato Blight

Accurate visual identification of foliar diseases such as Early Blight and Late Blight is essential for effective disease management, especially in field conditions where laboratory testing is unavailable. The following section outlines a structured, observation-based approach to differentiate between Early Blight and Late Blight in potato leaves.

1. Preliminary Assessment

The initial step in the identification process involves a general assessment of the leaf's health. A healthy potato leaf typically exhibits a uniform green coloration without any lesions, yellowing, or wilting. Once abnormalities such as spots or discolorations are detected, the observer should proceed to determine the specific nature of the disease.

Healthy Leaf

2. Characteristics of Early Blight (*Alternaria solani*)

Early Blight is a fungal disease that typically begins on the older, lower leaves of the potato plant. The hallmark symptom is the appearance of small, circular to oval brown lesions with characteristic concentric rings often described as a "bullseye" or "target" pattern. These lesions are commonly surrounded by a yellow halo, which intensifies as the disease progresses. The affected leaf tissue tends to dry out, and in advanced stages, the leaves may become brittle and fall off. Unlike Late Blight, the

Early Blight

spread of Early Blight is relatively slower, and the lesions tend to remain localized for a longer period before expanding.

3. Characteristics of Late Blight (*Phytophthora infestans*)

Late Blight, in contrast, is an aggressive and rapidly spreading disease that can affect any part of the potato plant. It typically presents as irregularly shaped, water-soaked lesions on the leaf surface. These lesions rapidly enlarge and turn brown to purplish-black. Under humid conditions, a distinctive white, cottony fungal growth can be observed on the undersides of infected leaves, especially along the margins of the lesions. Unlike Early Blight, the infection does not exhibit concentric ring patterns and often starts on the upper leaves. The infected tissue often feels soft and moist rather than dry and brittle. Due to its fast progression and potential to devastate crops within days, timely identification is critical.

Late Blight

4. Key Visual Differences

To summarize the differentiation: Early Blight presents as brown lesions with a defined circular shape and concentric ring structures, often encircled by yellow halos, and originates on older foliage. Late Blight, by contrast, manifests as large, dark, water-soaked patches with diffuse edges, frequently accompanied by white fungal growth under moist conditions, and spreads quickly across younger foliage and stems.

This structured, visual identification protocol is intended to assist farmers, agronomists, and AI models in field-based disease detection, forming a foundation for effective control measures and real-time classification in image-based systems.

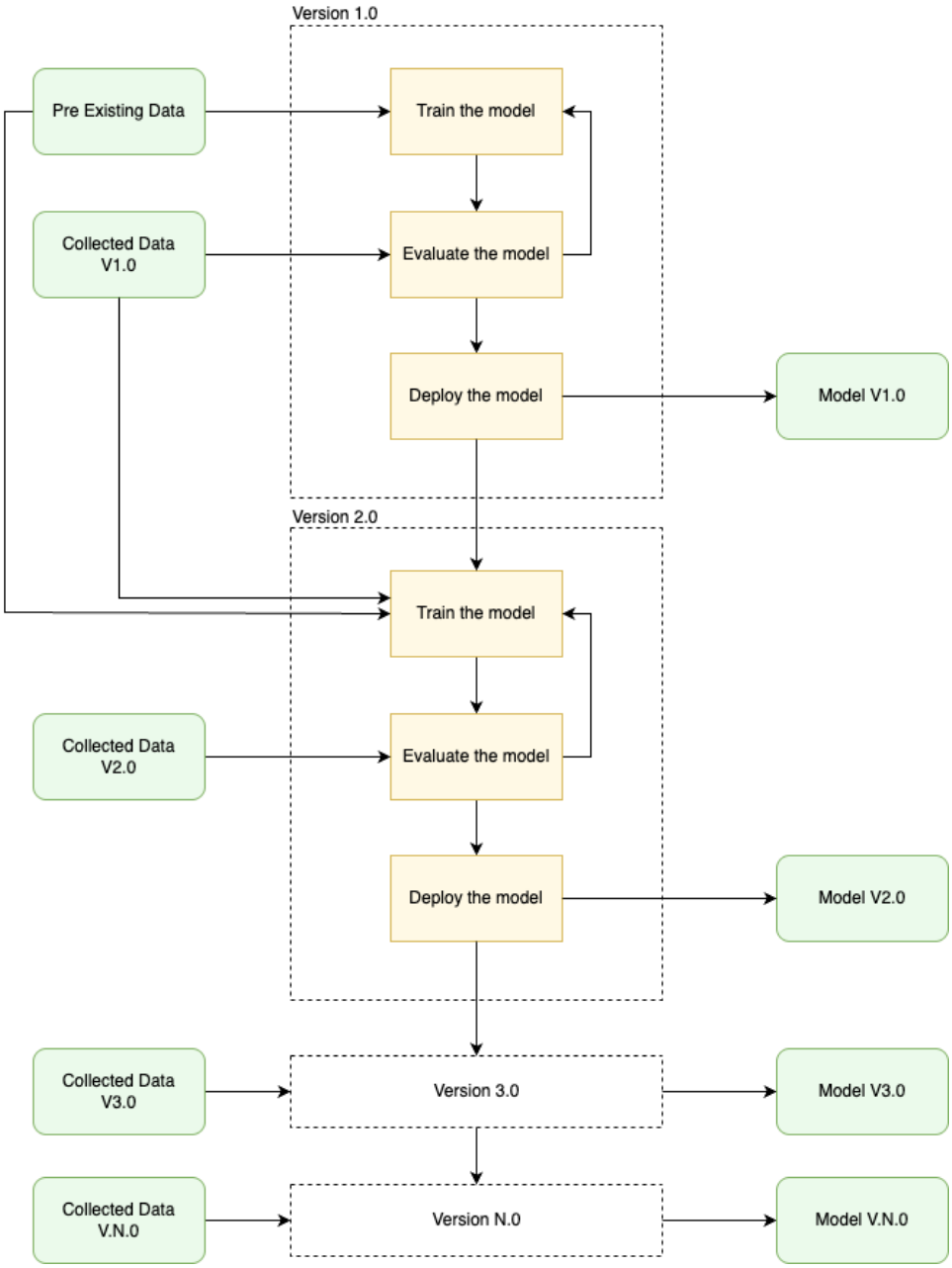
Our Research Approach

The primary goal of this research project is to develop a machine learning model capable of analyzing images of potato leaves to:

- Determine if a leaf is healthy or diseased.
- If diseased, classify the specific disease as late blight, early blight, or other conditions.

By leveraging image analysis, the model aims to assist in early detection and accurate diagnosis, facilitating timely interventions and reducing crop losses.

The architecture of this project follows an iterative, version-controlled approach to developing a machine learning model capable of detecting potato leaf diseases specifically Early Blight and Late Blight using image data. The process begins with training an initial model using pre-existing labeled datasets sourced from trusted repositories. While this model is being developed, image data is simultaneously collected from Sri Lankan farms to reflect local field conditions. This collected data is then used to evaluate the initial model. If the model's accuracy does not meet the desired threshold, further training iterations are conducted until satisfactory performance is achieved. Once the model is deemed reliable, it is deployed as Model Version 1.0.



Following the deployment of Version 1.0, the next phase involves combining the previously used pre-existing data with the newly collected local data to retrain and improve the model. During this stage, a fresh batch of images is again gathered from farms (referred to as Collected Data V2.0) to evaluate the retrained model. This ensures that the model is not only learning from historical datasets but also adapting to real-time field conditions and evolving disease patterns. When the model demonstrates improved performance, it is released as Model Version 2.0.

This cyclical methodology continues with subsequent iterations (e.g., Version 3.0, Version N.0), each one retraining the model with an expanded dataset and validating it with the latest farm data. The core objective is to continuously refine the model's accuracy and generalization capability, ensuring it remains effective and reliable in practical applications. This architecture not only allows for ongoing improvement of model performance but also makes the system highly adaptable to the specific needs and challenges faced by Sri Lankan farmers.

Impact of this Project on Sri Lankan Agriculture

Implementing this AI-based detection system is expected to have significant positive impacts on Sri Lankan agriculture, particularly for smallholder farmers:

- **Early Detection:** Timely identification of late blight can lead to prompt management actions, reducing the spread and severity of the disease.
- **Cost Reduction:** By accurately diagnosing the disease, farmers can avoid unnecessary pesticide applications, thereby reducing input costs.
- **Yield Improvement:** Effective disease management can lead to improved yields, enhancing food security and farmer incomes.
- **Data-Driven Decisions:** The system can collect and analyze data over time, providing insights into disease patterns and aiding in strategic planning.
- **Empowerment of Farmers:** Providing farmers with accessible technology empowers them to take proactive measures in crop management.

Given the challenges faced by Sri Lankan farmers, including those highlighted during the recent economic crisis where agricultural production fell significantly due to policy shifts and input shortages, this project offers a sustainable solution to enhance resilience in the agricultural sector.

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