Capstone Project Proposal: Optimizing Disease Management in Hop Production

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1 The Problem Area

My area of interest is probabilistic modeling, specifically focusing on the economic impacts of plant diseases in crop production. Within this area, a key challenge is optimizing disease management strategies to maximize profitability for farmers while minimizing environmental impact. The project could address the complex interplay between disease incidence, management costs, crop yield, and market conditions in hop production, as exemplified by the powdery mildew pathosystem (Gent et al., 2019).

2 The User

The primary users experiencing these problems are hop farmers and policymakers (US Department of Agriculture). Farmers would benefit from more informed decision-making regarding disease management, potentially increasing their profitability and sustainability (Gent et al., 2014). Policymakers would gain valuable insights into the economic impacts of plant diseases at both the farm and landscape levels, enabling them to develop more effective support systems and policies for the agricultural sector (Lence and Singerman, 2022).

3 The Big Idea

Machine learning can bring solutions to these areas by developing predictive models that integrate complex factors such as disease spread, management interventions, and market conditions. For example, machine learning algorithms could be used to:

1. Predict disease spread based on environmental conditions, crop susceptibility, and management practices (Ojiambo et al., 2017).

2. Optimize fungicide application strategies by considering factors like primary inoculum dose, pathogen diversity, and market demand (Nelson et al., 2015).

3. Forecast crop yields and quality based on disease progression and management interventions (Gent et al., 2014).

4. Simulate various scenarios to identify optimal disease management strategies that maximize profit while minimizing environmental impact (Cunniffe et al., 2015).

Previous approaches to this problem have used statistical modeling and simulation (Gent et al., 2019). Machine learning could enhance these methods by incorporating more complex, non-linear relationships and handling larger datasets with multiple variables (Lofgren et al., 2014).

4 The Impact

The societal and business value of this project could be substantial. In the hop industry alone, powdery mildew can cause significant economic losses. For instance, in severe cases, crops can be completely rejected or devalued (Gent et al., 2014). If we consider that the U.S. hop crop was valued at $562 million in 2023 (National Agricultural Statistics Service, 2023), then even a small improvement in disease management could result in millions of dollars in savings for farmers. Additionally, optimizing fungicide use could reduce environmental impact and slow the development of fungicide resistance, providing long-term sustainability benefits to the industry (Pimentel, 2005).

5 The Data

Several potential datasets for this project include:

1. The census survey data of hop yards, containing monthly disease assessments, cultivar information, and management practices from 2014 to 2017 (Gent et al., 2019).

2. Weather data corresponding to the surveyed regions, which could be obtained from local weather stations or satellite-based products.

3. Historical market data for hop prices and quality standards, which could be sourced from industry reports or USDA databases.

4. Fungicide application records and costs (Gent et al., 2019).

6 The Alternative

6.1 Identifying and Locating Sports Courts

Utilize Google satellite data and computer vision to identify and locate sports courts such as tennis, basketball, and baseball courts. There exists difficulty in finding these unlabeled courts and therefore there is a need for an app to be developed to make it easier for people to find and use these facilities.

6.2 Predicting stock prices using sentimental analysis and transfer learning

Build a machine learning model for predicting stock prices with sentimental analysis. Maybe use a pretrained model on movie reviews for positive and negative sentiments, and use transfer learning on this to measure sentiment of stocks via twitter feeds etc.

Use a neural network to understand who has the greatest influence on twitter that affects stock prices and then let the network give those with higher degree heterogeneity a higher weight.

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