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Crop Pests Prediction Method using Regression and Machine Learning Technology: Survey

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Abstract

This paper describes current trends in the prediction of crop pests using machine learning technology. With the advent of data mining, the field of agriculture is also focused on it. Currently, various studies, domestic and overseas, are under progress using machine learning technology, and cases of its utilization are increasing. This paper classifies and introduces SVM (Support Vector Machine), Multiple Linear Regression, Neural Network, and Bayesian Network based techniques, and describes some cases of their utilization.

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1. Introduction

This paper describes trends in work on methods of the prediction of crop pests using machine learning technology. It briefly introduces methods of using 4 algorithms using SVM (Support Vector Machine), MLR (Multiple Linear Regression), Neural Network, and Bayesian Network, and takes a look at various cases in which they have been used.

2. Prediction of crop pests using the technique of regression

2.1. Prediction of leaf moisture using a generalized regression neural network

Younes Chtioui et al. [1] assume in their paper that leaf moisture is difficult for men to measure on their own, and has important influence on plant disease break-out. Their paper has analyzed meteorological factors in predicting leaf moisture, and developed a Generalized Regression Neural Network (GRNN) for predicting the moisture based on them.

Their work was conducted by comparing the method of prediction via Multiple Linear Regression(MLR) and a GRNN, and time (a unit of 24 hours), temperature, relative moisture, wind speed, solar radiation, precipitation, soil moisture indexes etc. were used as a training set and a data set. As a result of the experiment, the MLR has shown average absolute value prediction errors of 0.1414 for the test set and 0.1300 for the training set. Under the same condition, the GRNN has shown average absolute value prediction errors of 0.0491 for the test set and 0.0894 for the training set. Consequently, it has been confirmed that the GRNN is more precise than the MLR.

2.2. Predictive evaluation of wheat pest using genomic information

A paper by Jessica Rutkoski et al. [2] suggests a method of predictive evaluation of wheat pest. The evaluative models include Ridge Regression, Multiple Linear Regression, Bayesian LASSO, Reproducing Kernel Hilbert Spaces Regression, and Random Forest Regression, and consequently, the model using genomic markers and Quantitative Trait Loci has the highest precision.

2.3. Prediction of Deoxynivalenol occurring on wheat using Multiple Linear Regression [3]

A paper by D. C. Hooker et al. [3] has found 3 periods and conditions of Deoxynivalenol occurrence by using MLR. Their work collected relevant information from 399 farms at Ontario in Southern Canada from 1996 to 2000 for the prediction of Deoxynvalenol occurrence. Daily precipitation, daily lowest/highest temperatures, and relative moisture per hour were used as weather factors, and as a result of the experiment, it has been confirmed that time points of wheat growth, rainfall, and temperature are related with deoxynivalenol occurrence.

Also, it has been confirmed that moisture has not to do with disease break-out, and the precision has reached about 89% with a threshold value of 2 micron grams.

3. Prediction of Crop Pests Using the Bayesian Technique

3.1. Technology of Pest Prediction Using the Naïve Bayes Technique and a Wireless Sensor Network

A. K. Tripathy et al. [4] have developed a real-time decision making system with which one can predict pests by means of a data mining technique and a wireless sensor network. They used the Gaussian Naive Bayes and the Rapid Association Rule Mining. Based on them, they have conducted work for the prediction of when pests will occur based on various pieces of information from the wireless sensor network.

3.2. Prediction of coffee rust disease using the Bayesian Network

Cora B. Perez-Ariza et al. [5] have carried out work on the prediction of coffee rust disease using the Bayesian Network. This disease makes earlier dead leaves and reduces yields. Data were collected in Brazil for 8 years in order to have people learn the model of prediction, and had people learn the model with data numbers given in temporal order using the casual minimum message length and a scoring matrix. Though the system could have lower performance than the decision tree, its merit includes high efficacy of the Bayesian Network in cases sensitive to contexts.

4. Prediction of Pests Using the Technique of the SVM

4.1. Prediction of wheat stripe rust by comparing regression and SVM

Haiguang Wang et al. [6] have compared the Regression Method and the SVM (Support Vector Machine) Method to predict wheat stripe rust disease. For this disease, one of the most critical diseases in China, prevention is very important. As a result of the experiment, the prediction using the SVM method showed high fitting and predictive precision, and was excellent on the side of speed.

4.2. Prediction of leaf miner infection using SVM

Wu Dake et al. [7] have conducted work on the prediction of leaf miner infection by means of SVM (Support Vector Machine). As for their method of study, they extracted information using image processing and spectrum analysis technology, and then predicted the infection by classifying degrees of leaf loss due to such infection and spectrum reflex rates using SVM. As a result of the experiment, the precision rate was 90% when 10 vectors were put in and multiple kernel functions were used.

5. Prediction of Pests Using the Neural Network Technique

5.1. Development of a Preceding Crop and Weather Data based model for Prediction of Wheat Deoxnivalenol

K. Klem et al. [8] have developed a model for predicting wheat Deoxynivalenol by means of Preceding Crop and Weather data. Data of average monthly temperatures, rainfall, and average relative moisture were used and a Neural Network was used as the method of prediction.

5.2. Development of a model for Prediction of Weather Condition Based Wheat Deoxynivalenol

Marie Váňová et al. [9] have carried out work on the prediction of the amount of Deoxynivalenol included in wheat grains in winter based on weather and wheat states. As a result, they have developed an AtriClim model in which Deoxynivalenol is predicted by using a Neural Network. The experiment was conducted with the wheat data from Australia from 2002 to 2005, and they found times of a high probability of occurrence and weather variables having much relevance.

6. A model for Web-based Prediction of Deoxynivalenol

S. Landschoot et al. [10] have developed a model for prediction of Deoxynivalenol by means of farm and weather data. This predictive model provides information of management strategies and recommendations via Web, and used data of rainfall, temperature, leaf moisture lasing time, atmospheric pressure, wind velocity and relative moisture, soil types, sowing dates, harvest dates, soil management technology, transferred crops, and germicide application. Cross-Validation using C-index was used as a predictive method, and the predictive model was evaluated on the basis of 3100 wheat sample data from 18 places in Belgium from 2002 to 2011.

7. Conclusion

This paper has made a survey of methods of prediction of crop pests using Machine Learning Techniques. The results of the survey can be summarized as in Table 1, and we can learn from this table that studies were inclined to particular crops. Those methods of prediction can help farms reduce damages and increase their income, and need to be extended so as to apply them to various crops. Table 1 summarizes the features of machine learning techniques based crop disease prediction techniques.

Table 1. Regression and Machine Learning Technology

No.	Type	Target to Predict	Proposed Techniques	Outputs
1	Leaf	Leaf wetness	Generalized Regression Neural Network, Multiple Linear Regression	Leaf moisture
2	Wheat	Fusarium Head Blight	Ridge Regression, Multiple Linear Regression, Bayesian LASSO, Reproducing Kernel Hilbert Spaces Regression, Random Forest Regression	Suggestion of methods of crop pest evaluation
3	Wheat	Deoxnivalenol	Multiple Linear Regression	Deoxinivalenol occurrence prediction
4	Agriculture	Pest/Disease	Gaussian Naïve Bayes, Rapid Association Rule Mining	Development of real-time decision making systems that can predict pests.
5	Coffee	Coffee Rust Disease	Bayesian Network	Coffee Rust Disease prediction
6	Wheat	Stripe Rust	SVM	Wheat Stripe Rust prediction
7	Leaf	Leafminers	SVM	Leaf miner infection prediction
8	Wheat	Deoxnivalenol	Neural Network	Development of Deoxnivalenol prediction model
9	Wheat	Deoxnivalenol	Neural Network	AtriClim model development
10	Wheat	Fusarium Head Blight	Cross-Validation using C-index	Development of a web-based model for prediction of Deoxynivalenol

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