Bayesian Belief Network to Diagnose Diseases of Potato

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Abstract

Because of plant diseases, there are two ways that profits from cultivation get affected. First, diseases increase the cost of production because of treatment costs. Second, it reduces revenue due to loss of potential yield. Therefore, treatment of plant diseases is vital to obtain optimal yields from the cultivation. Increasingly, farmers cultivate for commercial reasons than subsistence motives and hence, disease management is one important aspect of the plethora of decisions a farmer has to take. One major strategy stated in the national action plan for plant disease management of Sri Lanka is to develop technologies for rapid and precise identification of pathogens. However, as experience show, disease identification is not an easy task for which expert knowledge is necessary, which is not at hand for the common farming entrepreneur. Therefore, this study looks at the development of a simple web based tool to identify common diseases in potato cultivation. The objective of this study is to develop a Bayesian Probabilistic Neural network to identify diseases and develop a web based user-friendly interface that anyone could use to identify a disease by answering simple questions in the system.We use a probabilistic graphical model called a Baysian Belief Newtwork (BBN) for disease prediction. .A Bayesian network, or probabilistic network, is a model of a joint, or multivariate, probability distribution over a set of random variables. It has a graphical structure, G and an associated probability distribution, Pr. The graphical structure has a form of a Directed Acyclic Graph (DAG), G(V(G), A(G)) with nodes V(G), {V1.....Vn}, n ≥1 and arcs $A(G) \subseteq V(G) \times V(G)$. Each node V_i in the graph represents a random variable that takes one of a finite set of values. The arcs in the graph model the probabilistic influences between the variables. Thus, a variable V_i is dependent of its parents and children in the digraph, but is conditionally independent of any of its non-descendants given its

parents: the Markov condition. For each variable Vi in the digraph is a specified a set of conditional probability distributions $\Pr(V_i \mid \pi(V_i))$. Each of these distributions describes the joint effect of a specific combination of values for the parents $\pi(V_i)$ of V_i, on the probability distribution over the values of V_i. These sets of conditional probability distributions with each other define a unique joint probability distribution that factorises over the digraph's topology through: $\Pr(V_i,.....,V_n)\prod_{i=1}^{n}\Pr(V_i \mid \pi(V_i))$. As a Bayesian network in essence is a graphical model of a joint probability distribution over a set of random variables, the first stage in its construction is the identification of the important variables along with the values they may adopt. The selection of variables was based on a literature search and interviews with experts. The dependence and independence relationships between them were analysed and expressed in a graphical structure though interviews with domain experts. Bayes net was constructed using NETICA, which is a software specially developed for construction of BNs. NETICA, is a powerful, easy-to-use, complete program for working with belief networks and influence diagrams. The technique for assessing a network's quality is to perform a sensitivity analysis with real data. This is currently underway.

Keywords: Bayesian belief network; Plant diseases; Potato

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