Artificial neural networks for corn and soybean yield prediction:

http://www.sciencedirect.com/science/article/pii/S0308521X04001398

models could effectively predict Maryland corn and soybean yields for typical climatic conditions; (2) compare the prediction capabilities of models at state, regional, and local levels; (3) evaluate ANN model performance relative to variations of developmental parameters; and (4) compare the effectiveness of multiple linear regression models to ANN models. Models were developed using historical yield data at multiple locations throughout Maryland. Field-specific rainfall data and the USDA-NRCS Soil Rating for Plant Growth (SRPG) values were used for each location. SRPG and weekly rainfall means were necessary for effective corn and soybean yield predictions. Adjusting ANN parameters such as learning rate and number of hidden nodes affected the accuracy of crop yield predictions. Optimal learning rates fell between 0.77 and 0.90. Smaller data sets required fewer hidden nodes and lower learning rates in model optimization. ANN models consistently produced more accurate yield predictions than regression models. ANN corn yield models for Maryland resulted in r^2 and RMSEs of 0.77 and 1036 versus 0.42 and 1356 for linear regression, respectively. ANN soybean yield models for Maryland resulted in r^2 and RMSEs of 0.81 and 214 versus 0.46 and 312 for linear regression, respectively. Although more time consuming to develop than linear regression models, ANN models proved to be a superior methodology for accurately predicting corn and soybean yields under typical Maryland climatic conditions.

Classification of remotely sensed data by an artificial neural network: issues related to training data characteristics
http://cat.inist.fr/?aModele=afficheN&cpsidt=3496683

Artificial neural networks have considerable potential for the classification of remotely sensed data. In this paper a feed-forward artificial neural network using a variant of the back-propagation learning algorithm was used to classify agricultural crops from synthetic aperture radar data. The performance of the classification, in terms of classification accuracy, was assessed relative to a conventional statistical classifier, a discriminant analysis. Classifications of training data sets showed that the artificial neural network appears able to characterize classes better than the discriminant analysis, with accuracies of up to 98 percent observed. This better characterization of the training data need not, however, translate into a significantly more accurate classification of an independent testing set. The results of a series of classifications are presented which show that in general markedly higher classification accuracies may be obtained from the artificial neural network, except when a priori information on class occurrence is incorporated into the discriminant analysis, when the classification performance was similar to that of the artificial neural network. These and other issues were analyzed further with reference to classifications of synthetic data sets. The results illustrate the dependency of the two classification techniques on representative training samples and normally distributed data

A neural network based plant classifier

http://www.sciencedirect.com/science/article/pii/S0168169900001708

The Self-Organizing Map (SOM) neural network is used in a supervised way for a classification task. The neurons of the SOM are extended with local linear mappings. Error information obtained during training is used in a novel learning algorithm to train the classifier. The proposed method achieves fast convergence and good generalization. The classification method is then applied in a precision farming application, the classification of crops and weeds using spectral properties. The proposed method compares favorably with an optimal Bayesian classifier that is presented in the form of a probabilistic neural network. The classification performance of the proposed method is proven superior compared with other statistical and neural classifiers.

Neural Network-Based Irrigation Control for Precision Agriculture

http://ieeexplore.ieee.org/document/4525240/

In the present work, a design of an automatic irrigation neuro-controller for precision agriculture is presented. The irrigation neuro-controller regulates the level of moisture in agricultural soils, specifically in the root zone, using an on-off control-type that opens and closes the valves of the irrigation system (IS). The changes in the moisture levels in the roots area can be modeled as a non-linear differential function depending mainly on the amount of water supplied by the IS, the crop consumption, and the soil characteristics. This dynamic model is identified by a neural network (NN). After the NN is trained, it is used as a prediction model within the control algorithm, which determines the irrigation time necessary to take the moisture level up to a user desired level. At the same time, the NN is re-trained in order to get a new and improved model of the moisture's soils, giving to the IS the capability of adapt to the changing soil characteristics and water crop needs. In this work, it is also presented the main advantages of using this irrigation closed-loop adaptive controller instead of traditional systems that operates to open-loop, such as timed irrigation control.

An expert system/neural network model (ImpelERO) for evaluating agricultural soil erosion in Andalucia region, southern Spain

http://www.sciencedirect.com/science/article/pii/S016788099900050X

Soil erosion by water is one of today's most important environmental problems, in great part due to changes in agricultural land use and management. This paper illustrates the formulation, calibration, sensitivity and validation analysis of a hybrid model of expert decision trees and artificial neural networks (named ImpelERO) to evaluate the soil erosion process A total of 237 field units were selected, which represent 34 major land resource areas (MLRAs)for five traditional crops in the Andalusian region, southern Spain. The field units observed cover the whole range of erosion events, from what was considered very small to extreme erosion. Seventy-six per cent of the fields suffered small, moderate or large erosion problems. However, only 14% of the fields suffered very small, and 10% of the fields suffered very large or extreme erosion problems. Because of the complexity of the soil erosion process, and the interrelationships of the parameters, ImpelERO was developed as an Universal Soil Loss Equation (USLE) type model following traditional land evaluation analysis and advanced empirical modelling techniques. Using expert-decision trees, soil survey information and expert knowledge of the soil erosion process were combined through land and management qualities. An artificial neural network approach was then applied to capture the interactions between the land and management qualities and one output: vulnerability index (Vi) to soil erosion. The neural network was trained using the Correlation-cascade algorithm. The trained network estimated the output with a high degree of accuracy (maximum deviation 14%), and also had a good generalisation capacity. By means of correlation analysis, observed erosion vulnerability data were compared with predicted data using a previously developed model and using the ImpelERO model. The latter model gave more accurate results ($r = 0.91$) than the previous approach ($r = 0.66$). Along with the prediction of soil loss by water erosion, ImpelERO could be used as a optimisation tool for selecting the land use and management practices which satisfy the optimum environmental protection including reduction of soil erosion.

Application of Vegetation Indices for Agricultural Crop Yield Prediction Using Neural Network Techniques

http://www.mdpi.com/2072-4292/2/3/673/htm

Spatial variability in a crop field creates a need for precision agriculture. Economical and rapid means of identifying spatial variability is obtained through the use of geotechnology (remotely sensed images of the crop field, image processing, GIS modeling approach, and GPS usage) and data mining techniques for model development. Higher-end image processing techniques are followed to establish more precision. The goal of

this paper was to investigate the strength of key spectral vegetation indices for agricultural crop yield prediction using neural network techniques. Four widely used spectral indices were investigated in a study of irrigated corn crop yields in the Oakes Irrigation Test Area research site of North Dakota, USA. These indices were: (a) red and near-infrared (NIR) based normalized difference vegetation index (NDVI), (b) green and NIR based green vegetation index (GVI), (c) red and NIR based soil adjusted vegetation index (SAVI), and (d) red and NIR based perpendicular vegetation index (PVI). These four indices were investigated for corn yield during 3 years (1998, 1999, and 2001) and for the pooled data of these 3 years. Initially, Back-propagation Neural Network (BPNN) models were developed, including 16 models (4 indices * 4 years including the data from the pooled years) to test for the efficiency determination of those four vegetation indices in corn crop yield prediction. The corn yield was best predicted using BPNN models that used the means and standard deviations of PVI grid images. In all three years, it provided higher prediction accuracies, coefficient of determination (r2), and lower standard error of prediction than the models involving GVI, NDVI, and SAVI image information. The GVI, NDVI, and SAVI models for all three years provided average testing prediction accuracies of 24.26% to 94.85%, 19.36% to 95.04%, and 19.24% to 95.04%, respectively while the PVI models for all three years provided average testing prediction accuracies of 83.50% to 96.04%. The PVI pool model provided better average testing prediction accuracy of 94% with respect to other vegetation models, for which it ranged from 89–93%. Similarly, the PVI pool model provided coefficient of determination (r2) value of 0.45 as compared to 0.31–0.37 for other index models. Log10 data transformation technique was used to enhance the prediction ability of the PVI models of years 1998, 1999, and 2001 as it was chosen as the preferred index. Another model (Transformed PVI (Pool)) was developed using the log10 transformed PVI image information to show its global application. The transformed PVI models provided average corn yield prediction accuracies of 90%, 97%, and 98% for years 1998, 1999, and 2001, respectively. The pool PVI transformed model provided as average testing accuracy of 93% along with r2 value of 0.72 and standard error of prediction of 0.05 t/ha.

Neural network estimation of air temperatures from AVHRR data

http://www.tandfonline.com/doi/abs/10.1080/01431160310001657533

Multilayer feed-forward (MLF) neural networks were employed to estimate air temperatures in Southern Québec (Canada) using Advanced Very High Resolution Radiometer (AVHRR) images. The input variables for the networks were the five bands of the AVHRR image, surface altitude, solar zenith angle, and Julian day. The estimation was carried out using a dataset collected during the growing season from June to September 2000. Levenberg--Marquardt back-propagation (LM-BP) was used to train the networks. The early stopping method was applied to improve the LM-BP and to generalize the networks. Bands 4 and 5, which are used for retrieval of surface temperature, were the most critical components for the estimation. The contribution of Julian day to the precision of estimated air temperature was much superior to that of altitude and solar zenith angle for the dataset of inter-seasonal air temperatures. The network using all five bands, Julian day, altitude, and solar zenith angle provided the best results, with 22 nodes in the hidden layer. In the time series of estimated and station air temperatures, the difference between the temperatures was generally maintained within 2°C on various canopies, even during steep variations in August and September.

CLASSIFICATION OF BROADLEAF AND GRASS WEEDS USING GABOR WAVELETS AND AN ARTIFICIAL NEURAL NETWORK

http://elibrary.asabe.org/abstract.asp?aid=13944

Application of artificial neural networks in image recognition and classification of crop and weeds

http://s3.amazonaws.com/academia.edu.documents/41921749/yangetal.pdf?AWSAccessKeyId=AKIAJ56TQJRTWSMTNPEA&Expires=1477299824&Signature=rbt7qjhhT19H0lUScgUCemIXg1A%3D&response-content-disposition=inline%3B%20filename%3DApplication_of_artificial_neural_network.pdf

A portable soil nitrogen detector based on NIRS

http://link.springer.com/article/10.1007/s11119-012-9302-5

As one of the most important soil nutrient components, soil total nitrogen (TN) content needs to be measured in precision agriculture. A portable soil TN detector based on the 89S52 microcontroller was developed, and a Back Propagation Neural Network (BP-NN) estimation model embedded in the detector was established using near-infrared reflectance spectroscopy with absorbance data at 1550, 1300, 1200, 1100, 1050, and 940 nm wavelengths. The detector consisted of two parts, an optical unit and a control unit. The optical unit included six near-infrared lamp-houses, a shared lamp-house drive circuit, a shared incidence and reflectance Y-type optical fiber, a probe, and a photoelectric sensor. The control unit included an amplifier circuit, a filter circuit, an analog-to-digital converter circuit, an LCD display, and a U-disk storage component. All six absorbance data as inputs were used to calculate soil TN content by means of the estimation model. Finally, the calculated soil TN content was displayed on the LCD display and at the same time stored in the U-disk. A calibration experiment was conducted. The soil TN content correlation coefficient (R2) of the BP-NN estimation model was 0.88, and the validation R2 was 0.75. This result indicated that the developed detector had a stable performance and a high precision.

Geneteic algorithms

COLOR IMAGE SEGMENTATION WITH GENETIC ALGORITHM FOR IN-FIELD WEED SENSING

http://elibrary.asabe.org/abstract.asp?aid=2970

Information technology: the global key to precision agriculture and sustainability

http://www.sciencedirect.com/science/article/pii/S0168169902000959

Adaptive design optimization of wireless sensor networks using genetic algorithms

http://www.sciencedirect.com/science/article/pii/S1389128606001678

On the application of genetic probabilistic neural network and cellular neural networks in precision agriculture

http://researchrepository.murdoch.edu.au/25986/

Aerial coverage optimization in precision agriculture management: A musical harmony inspired approach

http://www.sciencedirect.com/science/article/pii/S0168169913002251?np=y

Remote Sensing With Simulated Unmanned Aircraft Imagery for Precision Agriculture Applications

http://ieeexplore.ieee.org/document/6837422/

Route planning for agricultural tasks: A general approach for fleets of autonomous vehicles in site-specific herbicide applications

http://www.sciencedirect.com/science/article/pii/S0168169916303908

Route planning in agricultural fields is a major challenge closely related to the amount of inputs consumed and the associated soil compaction. Current approaches primarily focus on reducing the travelled distances (i.e., the trajectories that vehicles have to cover to carry out the task) and generally do not consider other optimization criteria such as input costs (e.g., fuel, herbicides, labor). Furthermore, although few approaches consider more than one vehicle, none of them takes into consideration vehicles with different characteristics, such as different speeds or different turning radii, and some variabilities of the field such as the weed distribution have not been studied yet. All these factors affect the cost of routes to be followed to accomplish agricultural tasks such as site-specific treatments. In this context, this study proposes a very general approach to optimize the routes that considers: (1) different criteria such as the travelled distance, the time required to perform the task and the input costs, even simultaneously, (2) vehicles with different features (e.g., working speeds, both intra and inter-crop, turning radii, fuel consumptions, tank capacities and spraying costs), (3) the variability of the field and (4) the possibility of tank refilling.

The proposed approach has special relevance for route planning in site-specific herbicide applications. This case requires a tank on board the vehicle to store an agrochemical product, and its capacity must be considered because it affects the routes to be followed, specifically in those cases in which the tank capacity may not be sufficient to treat the entire field even when working in cooperation with other vehicles. In such cases, refilling (i.e., a round trip to the refilling depot) may be essential despite the extra cost involved in this operation.

The proposed approach was validated by solving several illustrative problems. The results showed that the proposed route planner covers a broad range of agricultural situations and that the optimal routes may vary considerably depending on the features of the fleet vehicles, the variability of the field and the optimization criteria selected. Finally, a comparative study against other well-known agricultural planners was carried out, yielding routes that improved those produced by the reference approaches.

Fuzzy logic systems:

1. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.631.320&rep=rep1&type=pdf
2. Fuzzy Logic Based Decision Support Systems - Heinrich J. Rommelfanger

Fuzzy Logic is a method to solve problems in expert systems which can be viewed as an extension of the classic set theory that deals with membership of the elements and the inferences that can be arrived. It also extensively uses the concept of probability theory to handle data that are uncertain and ambiguous. Using FL, imprecision data as well as vague images can be interpreted and analyzed. It is rich in operations which are based upon the set membership operations. The method encompasses of the fuzzy inference system as listed by Jang (1993): 1. a fuzzification interface that transforms the crisp inputs into degrees of match with linguistic values; 2. a knowledge base that includes : i. a rule base containing a number of fuzzy 'If–Then' rules; ii. a database that defines the membership functions of the fuzzy sets used in the fuzzy rules; 3. a decision-making unit that performs the inference operations on the rules; and 4. a defuzzification interface that transforms the fuzzy results of the inference into a crisp output. Though the above mentioned units forms as basic, however, more advancements had been made in the recent past which are more sophisticated and handles data that are most often considered to be as inputs for soft computing.

FUZZY LOGIC AND PROBLEMS IN AGRICULTURAL SCIENCE The domain of agricultural science has varied branches such as soil and seed management, water and irrigation, disease and pest control, weed management, fertilizers etc., The problems that are faced in each of these areas are complex as it involves many factors that constitutes and influence them such as geographical location, climatic conditions, weather changes and other organisms that infect them (plant pathology). All these makes the problem encountered, to be very difficult to formulate it in a particular model and devise a method to solve it in a traditional way. Since fuzzy logic uses the unconventional values i.e., values that are neither 0 (false) nor 1 (true), but lies between the interval of 0 and 1, it takes the probabilistic measure to quantify the parameters. Hence many problems whose parameters are difficult to be quantified, have also been solved, that would have been otherwise impossible if conventional methods had to be applied. Let us now review a few of the many areas where fuzzy logic had been successfully applied in the field of agricultural sciences.

[http://research.ijcaonline.org/icctac2015/number1/icctac2006.pdf] (more)