Prediction of frost location using machine learning and wireless sensor networks

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Abstract. The damage caused by the frost takes place when the temperatures are below than a tolerable limit for the plants. Each phenological state, e.g flowering, has a variable cold hardiness, so the lethal temperature is also variable. Freezing climatic events are the most dangerous, because they affect a large land surface. Mendoza is not an exception. According to the Instituto Nacional de Vitivinicultura (INV), in 2013 the loss of the vine crop reached up to 27%[1]. Big part of that loss of yield was during the early spring. In order to study the micro-climate phenomenon of frost in Mendoza, sensors were distributed in the vineyards vertically as well horizontally, because the air temperatures change vertically as horizontally, and the plant has also different cold hardiness in the organs like trunk, flowers, shoots.

Previous works on frost prediction have worked with data taken from meteorological stations very distant between them [3][2][4] or using wireless sensor networks (WSN) [5]. All of them have used supervised machine learning algorithms, such as artificial neural networks and support vector machines, with an particular configuration. For a better understanding of the phenomenon, we propose a study the sensor relationships in order to improve the frost prediction.

We are exploring the variables relationships using the independence approach by learning Markov Network structures from the environmental data corroborating with the opinion of an expert. The analysis of the Markov blanket of particular sensors helps to identify which neighbor sensors could improve the prediction. Our research is focused about the use of Markov networks as a supervised machine learning technique, for the feature selection purpose, and we are considering to use Markov Networks for inference.

On the other hand, we are also collaborating with a team of agronomic engineers, in order to study the traditional prediction techniques that they have used before. In this task, we are writing a survey about this topic, in order to highlight the open issues of the field.

Another problem we are interested in is how to optimize the sensor locations in a field, in order to maximize the prediction power of the algorithms.

References

1. El INV presentó el ajuste de la Estimación de Cosecha 2014. online news, Instituto Nacional de la Vitivinicultura, Mendoza, Argentina, February 2014.
2. Luca Ghielmi and Emanuele Eccel. Descriptive models and artificial neural networks for spring frost prediction in an agricultural mountain area. *Computers and electronics in agriculture*, 54(2):101–114, 2006.
3. Brenda B Lin. Agroforestry management as an adaptive strategy against potential microclimate extremes in coffee agriculture. *Agricultural and Forest Meteorology*, 144(1):85–94, 2007.
4. Imran Maqsood, Muhammad Riaz Khan, and Ajith Abraham. An ensemble of neural networks for weather forecasting. *Neural Computing & Applications*, 13(2):112–122, 2004.
5. P Sallis, M Jarur, M Trujillo, and A Ghobakhlou. Frost prediction using a combinational model of supervised and unsupervised neural networks for crop management in vineyards. In *18th IMACS World Congress-MODSIM09 International Congress on Modelling and Simulation*, pages 13–17, 2009.