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Calibration of a greenhouse climate model using evolutionary algorithms

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This paper presents a comparison of different evolutionary algorithms (EAs), such as Genetic Algorithms (GAs), Evolutionary Strategies (ES) and Evolutionary Programming (EP) to calibrate parameters of a climate model that describes the behaviour of air temperature and relative humidity (RH) within a greenhouse where a tomato crop is being grown. The objective was to determine which method generates parameter values that give the best prediction of the environment of a greenhouse located in the central region of México. Simulation and analysis of the climate model show that the estimations of the inside temperature and RH are closest to the measurements when EP was used to calibrate the parameters of the greenhouse model.

1. Introduction

An approach to achieve productivity in agriculture, especially when the global food crisis is growing and climate change is affecting agricultural production, is to cultivate crops in a greenhouse. Controlled environment agriculture technology has several advantages over conventional crop production such as greater productivity, better quality of produce, and low water and fertilizer consumption. Furthermore, productivity and quality of final products are related to climate conditions in which the crop is growing. Therefore, it is necessary to implement control strategies on variables such as air temperature, air humidity content and CO_2 concentration. Control of the system can be achieved through a mathematical model that predicts the climate conditions within a greenhouse taking into account external climate conditions (Castañeda-Miranda *et al.*, 2006).

In the literature many models based on physical laws have been presented, for instance the models by Bot (1983), de Zwart (1996) and Tap (2000), and in these models a detailed description of the climate conditions inside the greenhouse is possible. However, these are high order models and have a lot of parameters which are difficult to adjust due to the non-linear behaviour of the greenhouse climate model.

Mathematical models used to predict greenhouse climate require a suitable calibration of their parameters. The calibration process consists of altering model parameters to get a better fit between estimated and measured data (Tap,

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