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PREDICTION OF THE SOLAR RADIATION EVOLUTION USING COMPUTATIONAL INTELLIGENCE TECHNIQUES AND CLOUDINESS INDICES

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Abstract. *In this paper, Artificial Neural Networks are applied for multi-step long term solar radiation prediction. The input-output structure of the neural network models is selected using evolutionary computation methods. The networks are trained as one-step-ahead predictors and iterated over time to obtain multi-step longer term predictions. Auto-regressive and auto-regressive with exogenous inputs models are compared, considering cloudiness indices as inputs in the latter case. These indices are obtained through pixel classification of ground-to-sky images, captured by a CCD camera.*
Keywords: Neural networks, Multi-objective genetic algorithms, Solar radiation, Cloudiness indices

1. **Introduction.** Global solar radiation (SR) influences the majority of living beings in many different ways, which makes the accurate prediction of its evolution in time important for several different areas of application. One of the obvious areas of impact is the field of renewable energy (particularly solar energy) where a good prediction of the SR evolution enables efficient sizing and performance improvement of stand-alone photovoltaic systems [19, 22], and of hybrid power systems [4, 28]. A good review of applications in renewable energy systems, emphasising the use of SR forecasting, can be found in [16]. Another important area is people's comfort in buildings, where possible applications are luminance control [29] and thermal comfort. Regarding the last case, if the influence of SR in the buildings temperature can be modelled accurately, more efficient control strategies for heating, ventilation and air-conditioner ($HVAC$) systems may be employed, maintaining thermal comfort while minimizing the energy spent [3, 18, 27]. In a total different field, agriculture, SR plays an important role, for example, in the quantification of reference crop evapo-transpiration (needed in the calculus of crop water requirement), in irrigation scheduling or in water resource management [1, 13]. By the same reasons presented above in the context of a person's thermal comfort in buildings, the prediction of SR evolution allows more sophisticated climate control strategies which enables maximized crop growth and production [17] whilst minimizing energy [7, 25]. SR data is usually presented as a time series, for which there are no reliable statistical assumptions that may be employed. This makes nonparametric methods, such as artificial neural networks ($ANNs$) or neuro-fuzzy systems, good tools for modelling it. For this reason, several authors have employed these types of models for SR prediction [23, 24, 30], to mention just a few. We are interested in SR models as long term predictors to be employed in the predictive control of greenhouse climate and buildings thermal comfort. In previous works [8, 9, 26], one-step ahead (OSA) non-linear auto-regressive