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## Multi-objective learning of white box models with low quality data ☆

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## Abstract

Improving energy efficiency in buildings represents one of the main challenges faced by engineers. In fields like lighting control systems, the effect of low quality sensors compromises the control strategy and the emergence of new technologies also degrades the data quality introducing linguistic values. This research analyzes the aforementioned problem and shows that, in the field of lighting control systems, the uncertainty in the measurements gathered from sensors should be considered in the design of control loops. To cope with this kind of problems Hybrid Intelligent methods will be used. Moreover, a method for learning equation-based white box models with this low quality data is proposed. The equation-based models include a representation of the uncertainty inherited in the data. Two different evolutive algorithms are used for learning the models: the well-known *NSGA-II* genetic algorithm and a multi-objective simulated annealing algorithm hybridized with genetic operators. The performance of both algorithms is found valid to evolve this learning process. This novel approach is evaluated with synthetic problems.

**Keywords:** Genetic programming; Genetic algorithm and programming; Low quality data; Multi-objective simulated annealing; Energy efficiency

## Article Outline

1. Introduction
2. Low quality data in real-world processes
3. Algorithms managing low quality data
4. Learning models with low quality data
  - 4.1. Representation of vagueness in a GP model
  - 4.2. Representation of an individual
  - 4.3. The fitness function
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4.5. [Simulated annealing and the multi-objective approach](#)


4.6. [NSGA-II adaptation to LQD learning](#)

5. [Experiments and results](#)

6. [Conclusions](#)

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## Vitae



**José R. Villar** obtained his Engineering degree at the University of Oviedo (1992) and his PhD at the University of León (2002). He had worked for several engineering companies between 1992 and 1998. In 1998 he became an Assistant Professor with the Electric and Electronic Department at the University of León. In 2004 he became an Assistant Professor with the Computer Science Department at the University of Oviedo. Since 2008, he is an Associate Professor with this department. He had participated in several research projects and contracts with public and private funding and had published contributions in indexed international journals and ranked conferences as well as several book chapters. He is a member of the IEEE Systems, Man & Cybernetics Chapter Society Spanish Chapter. His research interests are focused in Genetic Fuzzy Systems, Meta-heuristics and Low Quality Data processing.



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**Dr. Javier Sedano** is an expert in the development of electronic systems – hardware – industrial projects and production-systems acquisition and control systems, “also in the design of connectionless models for the identification and modeling of dynamic systems”. He has directed and participated in many research and development projects for the development of prototypes in pre-competitive projects, competitive and industrial research. He is the head of the group of Artificial Intelligent and Electronic Applied at the Instituto Tecnológico de Castilla y León. Also, he is part of the Applied Computational Intelligence Group at the University of Burgos, a few years working on projects and publications related to artificial intelligence and system modeling. It also collaborates in the organization of international scientific conferences, program committees and organization. He is a member of the IEEE Systems, Man & Cybernetics Chapter Society Spanish Chapter. It has some international publications, book chapters and participating in conference, as well as records of software and industrial patents.



**Marco A. Garcia Tamargo** has a degree in Computer Engineering from the University of Oviedo, and PhD from the same university. He has worked in a private company developing and implementing Urban Traffic Control Systems. Since 1996 he works as Associate Professor at the University of Oviedo. His main areas of research so far has been the Traffic Control Systems, Distributed Systems, Multiagent Systems and Intelligent Systems for Risk Assessment based on data mining.



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