Applied Mathematics and Computation 267 (2015) 170–178

Contents lists available at ScienceDirect

Applied Mathematics and Computation

journal homepage: www.elsevier.com/locate/amc

Metadomotic optimization using genetic algorithms

S. Merino [a,*,1], J. Martínez [a,1], F. Guzmán [b,1]

[a] Department of Applied Mathematics, University of Malaga. Spain
[b] Department of Electrical Engineering, University of Malaga. Spain

ARTICLE INFO

Keywords:
Domotic
Metadomotic
Energy efficiency
Artificial intelligence
Genetic algorithms
Smart home

ABSTRACT

New technologies applied in domotic allow us to extract plenty of data about the usual behavior of occupants in any installation. Discipline that works with these data for the pursuit of new knowledge is called *Metadomotic*.

To achieve this learning and relationships between different data, we make use of the tools provided by artificial intelligence. Today the use of these techniques in solving problems is fully extended. Among the best known we will focus on the application of genetic algorithms, technical halfway between biology and mathematics, to try to resolve the issues raised in this paper.

This article proposes the classification of domotic parameters to optimize an objective function. In summary we will try two possible applications:

1. The minimization of energy consumption through the classification of the parameters of use and consumption coefficients, inherent to each user and device.
2. The maximization of industrial production through the influence of environment parameters .

Once established several basic suboptimal solutions, they will be combined randomly, through the crossover, mutation and cloning, to try to find the optimal.

1. Metadomotic

The Metadomotic is the field of science[2] which seeks to extract knowledge from the data reported by the users. From a practical point of view, their applications include those situations where different domotic solutions optimize an objective function, either energy, productive, industrial, biological, etc.

Display and control of domotic systems today possess storage devices where it is registered a large volume of data about installation functioning. Therefore as *metadata* help to locate and extract knowledge from data, the Metadomotic makes use of the stored information to learn from it and make an installation functioning more efficient. Thus establishing a parallelism with the definition of *metadata* in the fields of information technology and telecommunications, *"which is not relevant information for the end user but of utmost importance for the system that handles these data"*.

* Corresponding author.
E-mail addresses: smerino@uma.es (S. Merino), jmartinezd@uma.es (J. Martínez), f_guzman@uma.es (F. Guzmán).
[1] Partially supported by International Campus of Excellence Andalucia TECH.
[2] Journalist Bruno de Latour coined the term *domotic* in 1984. Domotic has been recently introduced in vocabulary as a composite word of Latin word domus and informatics, and it refers to intelligent houses meaning the use of the automation technologies and computer science applied to the home.

http://dx.doi.org/10.1016/j.amc.2015.04.029
0096-3003/

New technologies applied in domotic allow us to extract plenty of data about the behavior of the users of any installation. To achieve this learning and relationships between different data, we make use of the tools provided by artificial intelligence [20]. Using the classification proposed by Russel & Norvig, the artificial intelligence pursues four possible goals:

- Systems that think like humans.
- Systems that think rationally.
- Systems that act like humans.
- Systems that act rationally.

The algorithms included in this paper belong to *systems that act like humans* category.

Today the use of these techniques in solving problems is fully extended. Among the best known we will focus on the application of genetic algorithms, technical halfway between biology and mathematics, and to try to resolve the issues raised in this paper [9,16,18,19].

This article proposes the classification of domotic parameters of an installation to optimize an objective function. In particular we will try as possible applications:

1. The minimization of energy consumption through the classification of the parameters of use and consumption coefficients, inherent to each user and device.
2. The maximization of industrial production through the influence of environment parameters.

Obviously there are more applications where we can apply this idea.

1.1. Categories

In order to optimize the objective function, the parameters can be classified into several categories:

1. **Obligatory** (O_i): are those that the user is not willing to change under any circumstances. To be fixed, they must be unmodified and does not affect the search for the optimum solution.
2. **Variables** (V_i): are those parameters that you can modify within a range, depending on the needs of the time.
3. **Relatives** (R_i): those activities that should be carried out throughout the day, but which give the user some free day time of schedule for its realization.
4. **Complementary** (C_i): they arise when the increase of a parameter results in the detriment of another. Note that in this category *complementary* parameters will be formed by pairs (when a value of the pair grows, the other decreases).
5. **Supplementary** (S_i): are the parameters, calculated by certain domotic devices, that does not intervene in the optimization of the problem but which provide information of another type (controls of pollution, rain, wind, etc.).

Mathematically we understand this classification as a *full space of parameters*, since it integrates all the existing ones, and a same parameter, may not belong to two categories at the same time. Note that, depending on the problem, some of these categories may be empty.

Definition 1.1. Let X_i be a **Domotic Vector**, and we define it as:

$$X_i = (V_{i1}, \ldots, V_{in_V}, R_{i1}, \ldots, R_{in_R}, C_{i1}, \ldots, C_{in_C}),$$

where its coordinates correspond to the *variable*, *relative* and *complementary parameters*

Definition 1.2. Let x_i be a **Weight Vector**, and we define it as:

$$x_i = (v_{i1}, \ldots, v_{in_V}, r_{i1}, \ldots, r_{in_R}, c_{i1}, \ldots, c_{in_C}),$$

where each one of its coordinates take values in $\{1, 2, \ldots, 10\} \in \mathbb{N}$ and it represents the index of the preference to be modified by domestic system. Been 1 the least preferred and 10 those that are freely modifiable.

2. Energy efficiency

Nowadays any technique of construction is associated to the study of energy efficiency [3,4]. The constant increase in energy prices and the need for appropriate use of it facilitate the accomplishment of a special effort to the study of their optimum utilization.

At the same time incorporating domotic in these fields, through devices that can be controlled by the user or by a central computer, represents a new horizon in the achievement of the energy efficiency. Many of these electronic components currently possess the inherent capacity of accounting for the consumption of energy that passes through them, and