Abstract.
The aim of this paper is to compare the behaviour of a neural model and a fuzzy one in a problem of identifying urban traffic noise, for the solution of which both models would seem to be suitable. Many researchers have been involved with the problem of noise pollution in order to understand the phenomenon and to fully describe it. Several correlations have been found in literature by using statistical approaches; most of the proposed relations are linear and this characteristic represents a serious limitation to their capability in describing real situations. The work presented focuses on description of the approaches followed in creating the neural and fuzzy models. Analyses of the results obtained in the identification of urban traffic noise highlight the different behaviour of the two approaches in solving the problem.

1. Introduction
In the last decade, scientific activity in several fields of research has been characterized by the use of alternatives to traditional instruments. A case in point is certainly the use of neural techniques and fuzzy logic. Although the origins of both are more remote, it is only recently that they have achieved widespread consensus in various fields of application. The neural approach, with particular reference to mapping networks which are dealt with in this paper, is characterized by a certain comprehension difficulty, caused by the fact that the internal mechanisms which regulate its functioning are not clearly visible to the user. Conversely, the fuzzy logic approach allows the user to obtain a set of rules whose meaning can easily be understood and that can be used in practical applications. On account of their intrinsic characteristics the two instruments offer their best performance in fields which often differ greatly. The aim of this paper is to compare them in an application scenario which would seem suitable for both. The scenario consists of a problem of identifying urban traffic noise. Noise pollution in urban areas compromises the quality of life and can represent even a danger for people's health. This problem has received great interest from the scientific community. Many researchers have been involved with the problem of noise pollution, trying to understand the phenomenon and fully describe it [1]. The capability to model noise is of great importance because it allows action to be taken to limit noise pollution in urban areas. The main source of noise is represented by the flow of motor vehicles, but the influence of this on noise pollution is modified by some other physical parameters. Finding a model of noise pollution means searching for a relationship between the traffic parameters, some road parameters, urban parameters and noise pollution. Many correlations have been suggested in literature and were found by using statistical approaches; most of the proposed relations are linear and this characteristic represents a serious limitation to their capability in describing real situations. In [2][3][4][5] a neural approach to the problem of noise identification was proposed, and it was shown that it offers considerably better performance than that provided by classical approaches. In this paper the authors compare this neural model with a fuzzy one. The nonlinearity of the fuzzy approach allows one to capture complex interactions among the variables that
regulate noise pollution. Both models were obtained by using a set of measurements taken in various roads belonging to a typical European town and it can be considered a valid description of the situation of medium-size cities. The work focuses on the description of the approaches followed in the creation of the neural and fuzzy models. Analyses of the results obtained in the identification of urban traffic noise highlight the different behaviour of the two approaches in solving the problem.

2. Definition of the Identification Problem.

Several relationships have been proposed in literature to determine a model which expresses the relationship between noise pollution and the corresponding sources. In particular it has been assumed that it depends on certain urban parameters, among which the number, nature and speed of the vehicles, the characteristics of the urban area, the geometry of the road section (width of the road and height of the buildings), and the kind of road surface could be considered. Such a model, however, has a very complex structure and is hard to handle or even to identify. Therefore a simpler set of parameters must be selected and noise pollution must modelled as a function of the equivalent number of vehicles $n_{eq}$ (defined as $n_{eq} = n_{cars} + 3 \cdot n_{motorcycles} + 6 \cdot n_{trucks}$), the width of the road $w$, the average height of the buildings $h$ corresponding to the road section being considered. Noise pollution is generally identified through the sound equivalent pressure level $L_{eq}$. Having defined $L_{eq} = f(n_{eq}, h, w)$, identification of urban traffic noise consists of determining the function $f$. The neural and fuzzy solutions to the problem of identifying urban traffic noise are based on a collection of noise pollution measurements. These measurements are used for different purposes in the two approaches. The neural solution requires a set of examples so that the neural network can learn the function $f$, while in the second approach the measurements are needed to prepare the set of rules which allow the function $f$ to be realized. The data measured were obtained in Catania, a medium-size town of in the south of Italy. The outdoor acoustic surveys referred to sixteen locations in residential, commercial and industrial areas. The roads selected were both downtown roads and roads connecting outlying areas with the city. This choice was made in order to consider as various a set of data as possible. A class 1 phonometer was employed to measure the sound pressure level $L_i$. The measurement interval was 1 sec and each observation interval lasted ten minutes. Consequently, for each observation interval 600 $L_i$ values were measured and subsequently averaged in order to obtain the mean value of $L_{eq}$.

3. The Fuzzy Model.

In this section the authors show a fuzzy model for the evaluation of the acoustic noise. The fuzzy logic approach was aimed to obtain a set of $m$ rules of the following form:

$$\text{if } x_1 \text{ is } A_1 \text{ and } x_2 \text{ is } A_2 \text{ and } x_3 \text{ is } A_3 \text{ then } y_1 = g(x_1, x_2, \ldots, x_m)$$

where $y_1 = L_{eq}$ is the variable of the consequence whose value is inferred, $x_1 = n_{eq}$, $x_2 = h$, $x_3 = w$ are the variables of the premise that determine also the consequence, $A_1$, $A_2$, $A_3$ are fuzzy sets defined on the $x_1$, $x_2$, $x_3$ variables and with piece wise linear membership functions, and $g$ (assumed as a linear in the case of the proposed model) is a function that implies the value of $y_1$ when $x_1$, $x_2$, $x_3$ satisfies the premise. The final output $y$, inferred from the $m$ implications is given as the average on all the outputs $y_1$ of the individual rules. To establish which variables must be considered in the premise, to fix which is the shape for the membership function of each fuzzy set, and to define the polynomial associated to the consequence of each fuzzy rule a procedure proposed in [6] has been developed. The model obtained contains two fuzzy sets, labelled small and large for the $x_1$ and $x_2$ variables and no fuzzy set for the $x_3$ one, hence the model contains four